

latory authorities, seek to implement reasonable measures in line with good international mining industry practice, to mitigate the risk of non-performance of mine closure. A transparent description of objectives and outline of mine closure activities, timing and costing, procedures for securing funding, and updating and approval mechanisms are deemed to be essential and should normally be part of the EIA and information to be disclosed to the interested and potentially affected public. The specific risks which may affect mine closure and suggested forms of mitigation are listed below, in chronological order of potential events.

◆ **Premature termination during construction of the project** for technical or financial reasons can be mitigated with adequate completion guarantees which ensure that premature termination and abandonment will trigger an obligation by the guarantor to implement, or cause and fund a third party to implement, a satisfactory closure programme.

◆ **Material changes made to closure requirements and objectives** during the mine life can largely be avoided by agreeing a clear, transparent, up-front, realistic and approved definition of post-operational land use, the environmental performance standards to be met within a specified period of time, and sign-off procedures to be followed.

◆ **Material changes to the project and processes** may have implications with regard to mine closure requirements and related costs. Mine closure plans, the related costs implications and financial guarantees should be subject to a periodic review process, so that the implication of any material change can be assessed and addressed. This would also mitigate the risk of significant over- or under-capitalization of the closure funds and related guarantees which should reflect the life of the mining project based on proven reserve estimates.

◆ **The risk of financial failure** of the mining company and organizations involved in the financial guarantee (holder of cash reserve, trust fund, etc.) resulting in a failure to provide funding for mine closure can be mitigated by establishing non-accounting provisions monitoring financial performance, separating the financial structure for the closure fund from that of the company, allow-

ing only investments of closure funds in financial instruments providing 'assured' future payment, and spreading the risk to a combination of financial vehicles to jointly secure closure funds.

◆ **The danger of closure funds being redirected** can be mitigated by using a non-fungible financial structure and a certification process – involving a trustee, for example – ensuring appropriate use of proceeds, to safeguard against closure funds being used to pay for measures unrelated to the project, such as additional drilling, or repayment of loans in a default situation.⁴

◆ **The government might continue operating an 'inherited' project** without due consideration given to profitability and environmental consideration that would have otherwise required implementation of mine closure activities. Experience seems to suggest that funding limitations may 'discourage' the government from implementing mine closure in the absence of availability of funds earmarked for this purpose.

The need for technical assistance

The assistance provided to CEE and the FSU to facilitate privatization and international investments in the mining sector has, so far, not specifically targeted or incorporated issues related to mine closure and its financing. Now, further attention needs to be given to measures aimed at reducing potential long term adverse impacts by minimizing the risk of 'externalizing' mine closure activities and costs. This 'externalization' is a legacy experienced in many Economies in Transition resulting in local and regional adverse long term environmental and health impacts. A sector wide approach to this issue would capture all future mining projects, including those not funded by IFIs, and avoid the need to develop project specific and costly solutions to secure mine closure funding on individual operations. A programme should be developed and implemented to assist participating countries in developing appropriate policies and regulatory frameworks for mining projects and to provide a reliable framework for regulators, mining companies and operators, and investors in support of environmentally sustainable development in the mining sector.

The main objectives of this programme would

be to (a) review the current practices and deficiencies of the relevant regulatory framework of selected countries, (b) describe and illustrate 'good international practice' and financial implications, using selected case studies and jurisdictions, (c) develop a model policy and regulatory framework which could provide the basis of country-specific implementation, (d) provide recommendations on how this model framework could be adopted in the context of participating countries, and (e) define institutional requirements and funding needs to assist participating government and its agencies in implementing the recommendations. The out-put of the programme should also include recommended solutions for 'typical investment scenarios', with consideration given to project size as well as to the nature of the operation and financial strength, track record and other qualities of sponsors, investors, borrowers, and operators.

Notes:

¹ Closure and decommissioning issues are also relevant to other sectors, such as nuclear power, heavy industry, off-shore and on-shore petroleum production, and landfills and may have a significant impact on project economics and long term liabilities.

² Mining activities, more generally, can result in a number of other potentially significant adverse environmental impacts which are not covered in this article. Examples include subsidence, impacts on biodiversity and on the lives of local and indigenous populations.

³ US Bureau of Land Management's proposed amendments regarding the Surface Management Requirements for Mining Claims under the General Mining Laws (Subpart 3809 – Surface Management).

⁴ Industry representatives appear reluctant to accumulate closure funds in country-wide kept 'Environmental Funds' or relying solely on government agencies for either certification of appropriate use of proceeds or direct utilisation of these funds.

Social issues

Mining and the social imperative

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Abstract

Most mining executives are geologists or engineers, male and over 50. They can relate on some level to environmental scientists or technologists, but they are ill equipped to understand social scientists, community workers and community activists whose focus is on cultural and relational issues. Yet, increasingly it is the community groups and social activists that determine whether or not the company obtains its permits and/or tax and other concessions from national and local governments. And it is those same community groups, indigenous tribes and NGOs that can affect a company's image and stock prices worldwide. Uncomfortable though it may be, mining executives, government officials, NGOs and community leaders are finding themselves forced to work together.

Résumé

La plupart des cadres de l'industrie minière sont des géologues ou des ingénieurs de sexe masculin, âgés de plus de 50 ans. S'ils peuvent s'entendre à un certain niveau avec des chercheurs ou des techniciens de l'environnement, ils sont par contre mal équipés pour comprendre les chercheurs en sociologie, les travailleurs sociaux et les militants sociaux, principalement préoccupés par des questions culturelles et relationnelles. Pourtant, ce sont de plus en plus les groupes et les militants sociaux qui déterminent si une entreprise obtiendra des autorisations nationales ou locales les autorisations nécessaires et/ou des dégrèvements fiscaux et autres. Et ce sont ces mêmes groupes, tribus indigènes et ONG qui peuvent remettre en cause l'image de marque d'une entreprise et avoir un effet sur le prix des actions dans le monde entier. Malgré toutes les difficultés que cela peut poser, les cadres de l'industrie minière, les représentants des gouvernements, les ONG et les animateurs de communauté sont bien obligés de travailler ensemble.

Resumen

La mayoría de los ejecutivos mineros son geólogos o ingenieros, de sexo masculino y mayores de cincuenta años. Están capacitados para relacionarse hasta cierto punto con científicos o técnicos ambientales, pero no están preparados para comprender a los científicos sociales, trabajadores comunitarios y activistas comunitarios que se centran en aspectos culturales o relacionales. Sin embargo, los grupos comunitarios y los activistas sociales son quienes determinan cada vez más si la compañía obtiene o no sus licencias y/o exenciones impositivas u otras concesiones por parte de los gobiernos nacionales o locales. Y son esos mismos grupos comunitarios, tribus indígenas y ONG's los que pueden modificar la imagen de la empresa y los precios de las acciones alrededor del mundo. Por incómodo que resulte, los ejecutivos mineros, funcionarios de gobierno, ONG's y líderes comunitarios se ven obligados a trabajar en conjunto.

At ICSC we define sustainable development as development that enhances the economic, social and ecological well-being of current and future generations. John Robinson and his colleagues at the Sustainable Development Research Institute (SDRI) refer to it as an integra-

tion of economic, social and ecological imperatives. When it comes to mining issues, I am more inclined to SDRI's definition. What is emerging in the field is a sense of imperative that goes beyond a desire to enhance well-being. Companies cannot afford to invest in a mine unless they

are assured of a secure economic return over many years, and that in turn is more and more dependent upon their ability to take environmental impacts into account. This reality has been part of the mining scene for the past decade. A review of annual reports of the progressive and largest mining companies shows that environmental impact assessments have become a fact of life and considerable effort is put into mitigating the negative impacts of mining activities. Some mining executives argue that environmental science and technology has become mainstream in their companies.

It is often these same executives who see the emergence of social issues as by far the most difficult part of the sustainability triangle. They point with some trepidation to the complexity of relations with communities, indigenous tribes and with NGOs at both the local and international level. Most mining executives are geologists or engineers, male and over 50. They can relate on some level to environmental scientists or technologists, but they are ill equipped to understand social scientists or community workers whose focus is on cultural and relational issues (and whom, they can't help but notice, are often women). Nor are they comfortable relating to community activists whom they perceive as operating from an emotional base without sufficient access to the facts. Yet, increasingly it is the community groups and social activists that determine whether or not the company obtains its permits and/or tax and other concessions from national and local governments. And it is those same community groups, indigenous tribes and NGOs that can affect a company's image and stock prices worldwide. Uncomfortable though it may be, mining executives, government officials, NGOs and community leaders are finding themselves forced to work together.

A survey conducted by Dr. Allen Clark, of the East-West Centre in Honolulu, presented in the World Bank Conference on Mining and the Community in 1997, identified land access and

tenure and social cultural issues as first and second in order of importance internationally. Clarke concludes "The rapidly rising importance of social and cultural issues – such issues were not ranked in a corporate survey in 1990- and the need to deal effectively with such issues both domestically and internationally represents a clear and major structural change within the mining industry." Clarke argues that these issues have come to the fore for three reasons: the rapidity and shift of mining expenditures to exploration activities in developing countries; the trend for mining companies to assume a broader range of responsibilities for social and cultural issues previously left to governments; and related to these two, an emerging realization that companies need to be more proactive at all stages of the mining process – from exploration through to mine closure and reclamation.

So, what are some of the issues here? And within the sustainability triangle of economic, environmental and social well-being, what can mining companies, community groups and public officials do to address these issues?

1. Economic Issues

In assessing the economic return on investments and risks involved in a mining operation, social factors are becoming important to the bottom line. This comes into play at the first stages of exploration and continues until after closure. Progressive companies (juniors and majors), are becoming aware of the need to manage the community's expectations from the earliest stages of contact. If community relations are soured at the beginning, or if the community's expectations are unrealistic, later stages of development and negotiations will be difficult, protracted and costly.

In a market economy a company or sector can lose its share of the market as the result of a consumer boycott or bad reports in the media. This may be the result of only one incident in the operation of only one mine, yet when shareholder confidence is affected, the value of the company's stock drops. Similarly, one or two bad actors or a consumer revolt can affect the whole sector, such as the case with asbestos, and as threatened with copper. Consumer reactions are based on fear not facts. When consumers believe that there is a health issue involved they react by avoidance, not by checking the scientific basis of allegations. Anti-mining advocates appeal to consumers and affect their behavior on the basis of health, environmental, and human rights or social justice issues.

Another social aspect of the economic imperative is the question of equity – who benefits? This goes well beyond the traditional return on investment to shareholders and how it may be affected by markets and commodity prices. As the result of local and international pressure, most mining activity now leads to an increase in wage employment among those traditionally located in the mining territory. It changes the dynamics of communities from a subsistence economy to a cash economy – a change that has profound implications for traditional cultures. Increasingly com-

munities are questioning the overall distribution of economic benefits and are no longer willing to accept "a few paltry jobs for the locals" in return for giving up what they perceive to be their patrimony.

A related issue is the disruption of artisanal mining activity. From an environmental and occupational health perspective, small-scale mining is frequently problematic. To dislodge artisanal miners is often deemed necessary by the company gaining the mining concession. Placer Dome in Las Cristinas in Venezuela has worked out an arrangement with the local small scale miners that demonstrates the possibilities of a positive gain for both sides. According to Professor Jeffrey Davidson's presentation at the same World Bank Conference mentioned earlier, a community focused participatory 'Assessment Process' was used to consider and develop a collaborative small scale mining project that essentially involved: training and capacity building; accumulation of economic benefits on the part of the participating miners; and good relations based on participatory organizational structures between the company and the Association of Miners. Among the ingredients of success, Davidson includes "the use of specific tools and mechanisms to promote a participatory process from the outset: base-line socioeconomic and other surveys, key informants, group meetings (small and large), newsletter, photographs and videos."

At a national level, mining activity increases the GNP of the country in which the activity is located and contributes to a positive foreign exchange balance. The question from a social standpoint is not whether the mining results in increased income – but rather to whom does the money go? Critics point out the frequency of corruption and bribery of public officials (politicians and administrators) involved in obtaining licenses and permits. The gain to the national economy through taxes is real but is usually deposited in general revenues. It does not necessarily go back to the traditional residents of the land – who perceive the land as "theirs" and resent the gains going to those in far off urban capitals. Critics and activists point to a change in focus from livelihoods – with a shared sense of household and community responsibility for the basics of life – to a focus on the individual, money and consumer goods. To some, the benefits of mining far outweigh the negative outcomes of development, for others it is the opposite. In some remote communities men become migrant workers (flying in and out for periods of time). While this has less impact on the environment it disrupts family and community life. In other situations women are paid directly and in some cultures this undermines the traditional role of the males. Regardless of one's point of view, there is no denying that the influx of a new mining activity – especially if on a large commercial scale, has a major economic impact and related to that – has a significant social impact.

2. Environmental Issues

Elsewhere in this issue others provide a cogent discussion about the environmental issues associ-

ated with mining. The social and cultural side of these environmental issues is hard to ignore. For most of us, the climate and the natural environment within which we are raised has a profound and a deep subconscious effect on our well-being. It is not just indigenous tribes who share an affinity with mother nature – each of us retains a certain awe in the face of majestic beauty, of mountains, forests and grasslands. Mines are typically situated in remote and splendid scenic areas. The activity of mining almost inevitably involves altering that landscape and disturbing the flora and fauna. While it is also true that most ecosystems are more robust and resilient than one might expect, there is a point in each eco-system, where too much change can upset the ability of the eco-system to regenerate and adapt. The problem is not so much a scientific one – of assessing and mitigating or managing the risks – but also a social one of assessing, managing and mediating the perceptions of those risks. When scientists from the Smithsonian said that the Camisea area in Peru was able to accommodate much of the activity proposed by Shell Peru in their bid for a pipeline, international NGOs were dismayed and many opposed the development anyway. When scientists say that clear cutting is an appropriate way to log some forests in some ecozones, many environmentalists simply deny the data. It is never possible to predict the environmental impacts with certainty. Hence progressive companies and governments adopt the precautionary principle. But even so, they are faced with the problem of perceptions and of cultural impacts, not so easily handled. It is essential that companies complete environmental impact assessments to the same standard as they would in their own country whether or not this is a requirement of the developing country in which they wish to operate. To do less is to invite attack by critics in the developed country that is home to the company. As well a sound Environmental Management System is also expected of international mining companies these days.

3. Social Issues

The major social issues related to mining activity have to do with cultural diversity and with decision-making processes. Mining activity affects health, culture and traditional roles within local communities and the power relationship between the local community and the national government. The progressive companies offer training to locals and frequently negotiate a variation of an affirmative action programme to ensure that community residents are used for as much of the labour in the mining activity as is considered possible. In addition to jobs and training, mining companies frequently build schools and hospitals or health facilities for workers and their families. They can point to significant economic and social benefits from their activity yet critics point out the unintentional consequences of contact with the exogenous mining personnel and a foreign culture: the influx of diseases against which indigenous groups do not have natural immunity (sexually transmitted diseases being only a minor component of the problem); the devaluing of

indigenous traditions and cultures; and increased interaction with the global community; There is no monetary value one can place upon respect for ones elders and a belief that their burial place is sacred. So how can it be negotiated in monetary terms? Often what emerges in truly remote areas is the meeting of a culture based on money and a culture based on nature. When indigenous peoples in Canada's north were asked to rank five core values their priorities were in sharp contrast to those of their white neighbours. To indigenous people the most important value was the Creator, followed by the natural world, the community, the family and then the individual, in that order. To white southerners, the hierarchy of values was the reverse, with the individual as the most important, the family, the community, the natural world and then God. When two such different world views come into contact it is very difficult to bridge the gap in understanding.

At the Prospectors and Developers Association of Canada's short course on Community Relations in Developing Countries in 1998, Ian Thompson spoke of another kind of cultural differences: the difference in cultures between the junior companies – exploring in secrecy and talking up eventual finds so as to sell their stake or gain investors – and the community's need for openness so as to have realistic expectations about what gains they will receive from mining activity. This is another gap in communication that needs to be bridged.

What can those of us do who wish to affect mining policies and practices do to ensure that it contributes to the sustainability of livelihoods and communities?

First, if one agrees that the public perception of mining is important to obtaining and maintaining the company's right to operate, then the company must gain the trust of the community and the public. This can only be done by acting in a socially responsible manner. People trust those who do what they say they will do. That means addressing health, environment and social justice issues directly and immediately, from point of first contact to long after closure. If a company does it right often enough it is likely that this will be noticed. Where there is a track record of good practice and openness, even ardent critics are hard pressed to gain support for their campaigns. Don't just talk about it, do it and talk about it. Most importantly, keep printed or video documentation in a moderate and informative style. Slick glossy public-relations sales pieces simply reinforce distrust and the community's perception

that the mining company is rolling in money, and that in turn leads to inflated expectations.

Perhaps the best example of which I am aware where a resource company involved the community, the indigenous people, the local and national government, scientists and the national and international NGO community in a transparent process was the case of Shell Peru in the Camisea Project. Forced to learn from the negative experience of its sister company in Nigeria, the Shell company in Peru invested itself in a time consuming and expensive process to share decision making, ensure that minimal disruption to the environment occurred and that those affected by the development would gain from it. It is sad and ironic that those efforts were ultimately not rewarded and the deal was not consummated. Nonetheless, Shell deserves credit for changing much of its corporate behavior at least in Latin America, after the criticism of their practices in Nigeria.

As well as community and public support, a mining company needs political support from the local and national governments. In many countries bribery is an expected way of doing business. Unfortunately, bribery and corruption are not compatible with long term sustainable development nor with public perceptions and the international status of countries or companies in the developed world. The three most effective strategies of which I am aware to prevent corruption are: to support the rule of law and good governance in the country; to offer the whole community an equity position in the mining operation; and to use transparent multi-stakeholder processes to discuss and make decisions and disseminate results. When mining companies bring in their own para military presence they change the dynamic from one of cooperation for mutual benefit to one of intimidation. When the community as shareholder shares the benefits of economic efficiency, it generally does not tolerate expenditures on bribes to individuals. The perceived betterment to the community as a whole reflects positively on the politicians involved, even when it does not add to their private finances. Finally, open roundtable processes involving key stakeholders or their representatives makes clear the benefits of honesty and the costs of bribery. In one developing country in Asia for example, it was open dialogue about the costs of dust controls with scientists in a round table on occupational health, that led industry leaders to realize that they were paying more in bribes to officials than it would cost to just install the equipment.

Summary and Conclusions

For mining activity to contribute to sustainable livelihoods and communities requires changes to policies and practices. Economic issues are related to the sharing of gains from the mines in a more equitable manner and the broader sharing of decision making with those affected. One of the best examples of a successful partnership arrangement between indigenous peoples and a company is Comico's Red Dog Mine, in Alaska.

Companies tread a fine line between the need to relate and contribute directly to the local community and the difficulty of becoming a substitute for local or national government. The establishment of a foundation or Trust is a useful mechanism to share the benefits over the long run. If properly structured, it may also allow an arms-length decision-making process to occur that empowers the community without detracting from the role of government.

Mitigating health and environmental damage is essential to any company that expects to operate over a period of time in a developing country. Protecting the ecosystem and the culture of the area is often served by a fly-in fly-out option, as is becoming increasingly common in remote areas.

Because so much of the relationship between a company and the community is based on an unequal power relationship, capacity building to increase the local community's negotiating skills and – for both the community and the company – to improve conflict resolution mechanisms is a good investment on the part of the companies, the governments and international financial institutions and aid agencies. Disputes are healthy and inevitable in the development game. To prevent their becoming armed conflicts or violent is essential. It is surprising that so few development projects involve skill training in negotiations and conflict resolution.

Finally, the essence of sustainability involves a rather simple and profound respect – in UNEP's terms – “for life on earth”. Respect involves accepting imperatives – whether that is the economic imperative to raise the standard of living and quality of life for the poor, and respect for economic diversity; or the environmental imperative to maintain our life support systems of water, air, soil, shelter and energy, and respect bio-diversity; or the social imperative to maintain harmonious human relationships and respect cultural diversity. The challenge is for mining to contribute positively to these three imperatives.

The dialogue between environmental and community groups and the mining industry in South Africa

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As in most countries, the average South African understands mining to be "dirty, dark and dangerous". However, the average South African is also aware that mining contributes a huge amount to the national economy. Thus many people have a love-hate relationship with mining. They tend to see it as a necessary evil. As the epitome of big business, the mining industry has not been known for listening to stakeholders. Thus it comes as a surprise to most South Africans to hear that there is a well-established dialogue between environmental non-governmental organisations (NGOs), community-based organisations (CBOs) and the mining industry.

How it all began

Following the democratisation of South Africa in the 1980s, civil society has had the opportunity to influence public policy as never before. In fact, participation in policy development and law-making has become an entrenched way of life. Environmental legislation has not been left out of this process, and one of the most significant acts to emerge has been the National Environmental Management Act, promulgated in 1998, and enacted early in 1999.

In the process of developing this act, stakeholders had the opportunity in mid-1998 to make representations to the Parliamentary Portfolio Committee on the Environment and to present their views on the draft act. Business and industry, including the Chamber of Mines, and several NGOs, including the Environmental Monitoring Group (EMG), made presentations at the same hearings. The representatives of both groups realised that, remarkably, their presentations hinged on the same concept, namely sustainable development. There also appeared to be a significant degree of commonality in the approaches presented. In discussing this after the hearings, the Chamber and EMG agreed to explore this common ground, and perhaps to begin to address some of the differences between the mining industry and NGOs and CBOs.

NGOs, CBOs and industry representatives held informal meetings to get to know one another better and to identify areas of common interest. An agreement was reached to work together on:

- ◆ development of guidelines on public participation for the mining industry;

- ◆ identification and development of conflict resolution mechanisms; and
- ◆ discussions on aspects of sustainable development.

Outcomes of the dialogue

While the meeting of minds that occurred in the parliamentary corridors was an achievement in itself, the ongoing dialogue has since resulted in the forms of two workshops, a dialogue on the Far West Rand goldfields and a website.

First exploratory workshop

It was agreed that the dialogue that was developing was too important to limit to a few individuals in the different groups. Thus a jointly hosted workshop was arranged in February 1999 as a first step in opening up the debate and in broadening the contact between the different parties.

The workshop was attended by approximately forty mining industry representatives and twenty NGO and CBO representatives. The first part was devoted to discussions on public participation. The mining industry highlighted the fears and problems it faces when dealing with the public, while the NGO/CBO sector presented its vision of the process which had been initiated. A discussion on sustainable development generated much debate. Though participants agreed to differ at this early stage, it was acknowledged that, as a balance was being sought between social equity, ecological integrity and economic development, trade-offs between the three would be inevitable.

The most immediate outcome of the workshop was the initiation of contact between at least two mining operations and relevant CBOs. Smaller dialogue groups were set up in order to address problems at these operations. Less tangible, but very important and encouraging was the realisation by all involved of the "reasonableness" of the representatives of the other sectors. In order to continue the dialogue, a task team comprising representatives from each sector was constituted.

Certain common problems were identified, including:

- ◆ The mutual lack of understanding of the terms of reference of the other groups;
- ◆ The difficulty experienced by mines in identifying genuine community representatives;
- ◆ CBOs said that they often do not fully under-

stand the implications that a mine will have on their lives.

This workshop was the first time participants from both groups interacted in a non-confrontational situation and the organisers were pleased with the results. Participants concluded that, although high hopes were pinned on the dialogue, there was no fixed vision of the outcome; the dialogue was a process, not an end in itself.

Far West Rand goldfields dialogue

The Far West Rand is one of South Africa's richest goldfields and has contributed a significant proportion of the country's gold output since it was opened in the 1950s. However, the gold mining operations have had significant impacts on ground and surface water in the area. In 1998, some poor subsistence farmers approached Gold Fields, one of the mining companies in the area, with a request that they be provided with free, good quality water. The company was initially reluctant to do so, and was under no obligation to provide the water. The situation was complicated by some wealthy farmers who wished to obtain water for themselves.

The task team referred to above met with community members soon after the workshop. The very fact that the Chamber (on behalf of industry) and the NGOs/CBOs were working together helped to defuse the situation. This joint approach was, in itself, revolutionary, and provided a graphic illustration that compromise was possible. Following this, the task team met with Gold Fields and explained the farmers' position. Gold Fields expressed a willingness to assist farmers in genuine financial need. It organised a mining forum comprising mines in the area (including those from other mining groups as well) and community representatives. The forum will soon meet for the second time. Farmers and miners appear pleased with the dialogue that is taking place. The task team's role has been catalytic. It will continue to facilitate during the process of developing the relationship and building trust.

Workshop on public participation

The first workshop had identified the need to discuss public participation in decision making regarding both mine authorisation and ongoing operational matters. A questionnaire sent to par-

ticipants in that workshop revealed that there was strong support from all sectors for an industry guideline on the subject. Thus a second workshop was held in May 1999 to consider a proposal for a voluntary clearing house as a means of resolving conflict, to reflect on the implications of a recent legal judgment against a mining authorisation on environmental grounds, and to initiate debate on the format of the guideline.

The clearing house idea was refined to a recommendation that a database of contacts in industry, NGOs and CBOs be developed and placed on a website. The reason for this was that its purpose was to facilitate communication and the resolution of conflicts, whereas posting news of conflicts on the internet via a clearing house had the potential to inflame conflict situations. The website is discussed in greater detail in the next section.

The legal judgement referred to above concerned a proposed coal mine which was approved by the regulatory authorities, although that decision was overturned by the courts. The judgment referred to the concept of sustainable development, as enshrined in the new National Environmental Management Act, for the first time. It explicitly recognised a change in ideological climate which required a holistic view to be taken with respect to development decisions. It set an important precedent in South African administrative law in terms of which decisions made by officials can now be re-evaluated by the courts. Of even greater importance was that decision making has now been devolved to the community. Government officials can no longer make decisions, but need to "extract the common will of the community".

There was little agreement on the format of the guideline because of differing expectations of the breadth of issues it should include, and doubt as to its enforceability. However, discussions have advanced since then, and this subject is returned to below.

The "Mines and Community Contacts" website

As has been stated above, the purpose of the website (www.cominfo.org.za/mcc/mcc.htm) is to facilitate dialogue between mines and communities, thus preventing disagreements from escalating into conflict situations and to defuse conflicts. It is a voluntary joint initiative by some members of the Chamber of Mines and by some NGOs and CBOs. It has no legal status. It is certainly innovative in South Africa, and we know of no such project elsewhere in the world.

The website was officially launched by the Minister for Agriculture, Conservation and the Environment of Gauteng province, Ms Mary Metcalf, in February 2000. For NGOs and CBOs, it provides contact information and a brief description of the organisation's activities and areas of operations. Since many organisations are known primarily by their acronym, a list of organisational acronyms is also given. The information is provided so that mines can know who they are talking to or can talk to, and to help communities to find

organisations that can assist them.

Mines may be listed alphabetically or by managing company. Their contact details are more extensive, being structured in the order of on-site environmental manager, followed by the mine manager, then a head office contact, then a contact at the Chamber of Mines. An explanatory page on the website invites members of the public to contact the on-site environmental manager if there is an issue they wish to discuss with the mine. If the matter is not resolved, then they are asked to contact others on the list, in the order in which they appear. The principle being followed is that disputes should be resolved at the most appropriate level, with higher-level people available to intervene should people at the lower levels be unwilling or unable to address them. As a last resort, the Chamber is available to act as a relatively neutral broker between the mine and the community: it has no managerial authority over its member mines.

Clearly, the website is not a definitive answer to the issue of conflict resolution. Shortcomings include:

- ◆ Limited internet and even telephone access in poor communities. In order to address this, a hard copy version is being distributed in such communities, though of course this will be out of date as soon as contact details change or new mines or organisations are added.
- ◆ There is no obligation on mines or the Chamber to resolve issues. However, since listing on the website is voluntary, it is reasonable to assume that the companies that have submitted their details are committed to the process. Certainly, the Chamber's credibility is at stake, and it will do all it can to ensure the website's success.
- ◆ Only a limited number of companies and organisations are listed on the website, but because of the matter raised in the previous point, participation must be voluntary. Pressurising reluctant mines to contribute their details could compromise the entire database. Additional NGOs and CBOs are expected to be added shortly.
- ◆ Companies have expressed concern that the website would be used by people looking for work. However, this has not occurred to date.

From April to June 2000, the website was accessed three to four times per day and by sixty to ninety people each month. The figures for July, the latest available, are many times higher, so there is a question of accuracy. Considering the size of the user group for the website, people are very pleased with the level of access.

Because the website is still quite new, its success in promoting communication between mines and communities has not yet been assessed. By definition, if it is successful, issues will be resolved before they reach the Chamber, so no news might be good news. However, the Chamber is in the process of contacting mines, NGOs and CBOs for feedback on their experiences with the website.

Work in progress Industry guideline on public participation

Stakeholder consultation as part of an environ-

mental impact assessment (EIA) is a requirement for mining approvals in South Africa. The growing world-wide trend to include stakeholders in decision-making on operational matters is also taking hold. The change has largely been driven by the shift from the autocratic apartheid state to an inclusive, consultative democracy. However, there has been no guidance from government as to what constitutes adequate consultation. Companies find themselves under pressure to open up but are naturally reluctant to divulge what they understand to be confidential information. On the other hand, communities encounter differing degrees of information sharing from companies.

In order to address this gap between expectations and output, or demands and perceived reasonableness, the industry/NGO/CBO task team is preparing an industry guideline on public participation. It sets out the process and extent to which companies should consult with stakeholders in carrying out EIAs thus enabling both sides to judge what is reasonable with some measure of objectivity. It is expected that, at some point in the future, the guideline will either be adopted by government, or that it will form the basis of a government guideline on public participation.

Mining and sustainable development

The realisation that sustainable development is a paradigm common to industry, NGOs and CBOs sparked the dialogue in South Africa. Not surprisingly though, partners differ in their understanding of what this means in practice. Thus, part of the ongoing dialogue consists of a debate on this matter. To a large extent, this debate has been overtaken by the Mining, Minerals and Sustainable Development project, which has an important regional component in Southern Africa. In a country with a significant proportion of its population living in dire poverty, in a region which is even poorer, this debate will continue for many years to come.

Conclusions

We, as representatives of the South African mining industry, NGOs and CBOs, are proud of what we have achieved in setting up this multistakeholder dialogue. We could not have done it alone. The post-apartheid miracle has been evident in the mining industry, once a symbol of conservatism and oppression. However, to a large extent, only the easy part – the dialogue has been completed. The next part, changing behaviour, is proving to be and will be more difficult. It will never be a glorious march towards the sunset, but will always involve steps backwards as well as forwards. But we are confident of ultimate success because we believe that a profound change has already started to take place as a result of the dialogue – attitudes are changing. Therefore we believe that behaviour will slowly, but inexorably change too.

Reference

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If you give you must always expect twice in return – a South African's experience in Canada

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I'm one of a party of about twenty-five people, on a traditional Indian canoe paddling off the Island of Vancouver in the Pacific ocean. It's getting dark and the temperature has dropped to below zero at water level and it is only the rhythmic paddling that keeps us from freezing up.

At the helm, just visible in the dark, is a native North American – or First Nations as they prefer to be called – who is slowly beating a drum and singing in an ancient chant. The water rushes past the gunwales and one feels the power and stability of the canoe as it surges towards a dark shape on the horizon, an island some kilometres off.

This is not some tourist Eco-tour or a scene from a movie set but a collection of First Nations people from the local village who, together with us – researchers from the Minerals and Energy Policy Centre in Johannesburg – make up this strange modern day Indian raiding party. The purpose of our visit is to study how the First Nations people are dealing with issues such as land restitution claims, mineral rights and the continual shifting boundaries between what constitute their traditional rights and the rights of the provinces and the state.

The mythology of the North American Indians, the First Nations, is deeply entrenched in the psyche of North America. Whilst they have been marginalised and their culture all but destroyed by the North American settlers, the mythology around them still exerts a powerful fascination over American and Canadian whites. Off-road vehicles are given traditional names such as Cherokee whilst mainstream advertising has capitalised on the myth of the pure native American way of life before it was buried under centuries of colonisation. The irony is that hardly any whites have entered a First Nations reserve and knowledge of their culture and traditions has only been preserved by oral history. But they are attempting to restore their identity and to tackle the enormous problems of alcoholism, drug abuse and family disintegration which have resulted from the fragmentation of their traditional way of life.

The man paddling in front of me is called Dave Cole. He is a Mohawk and a community activist. He's been brought in to tackle some of the social issues confronting the Kwakiutl community in Port Hardy, where we are being hosted. After we reach shore many hours later he expounds on the issues facing the community. "The fault lies in the past policies," he says in his North American

drawl. "Up until the sixties we were not allowed to speak our own language, or practise our customs or religion. To reconstruct our history is going to be an enormous task." All around the village there is evidence of economic hardship. The community has suffered the twin problems of diminishing salmon runs and deforestation, both central to maintaining the traditional First Nations lifestyle. In addition, the closure of a copper mine in the region has led to further unemployment in the community.

But the First Nations have kept some aspects of their culture. Whale watching for instance. On the horizon to the West of the canoe the waters suddenly part and a forty foot humpback whale emerges from the depths as if in slow motion, its entire mass completely exposed for a split second. It then crashes down into the water, its enormous tail slowly submerging like a fan. It's no more than fifty metres away and I am seized with panic. I know from my sailing days that whales can sink yachts. The villager in front of me assures me that whales are peaceful creatures. "If you don't interfere with them they leave you alone," she says nonchalantly. I guess that centuries of intimate knowledge of whale behaviour count. But I'm still not relaxed.

We're reaching the shore. It looms up a dark mass and the heavy canoe, carved by hand out of a massive cedar log, grinds to a halt on the beach pebbles. We all climb out and haul it up to shore. Some First Nations people are there to greet us and they escort us up to a camp fire on the beach. We all huddle around the fire. Then two men burst into chant. It's beautiful and lyrical and it recalls ancient voices. When they have finished they turn to us. "Do you sing? We want to hear songs from Africa."

We line up and attempt to sing the National Anthem. It's not the best rendition but we get applause anyway.

It's getting colder and we all return to the canoe and begin the four kilometre paddle back to the village. I can't tell you how beautiful it all is.

Back at the original point of departure we haul the canoe on to the beach and make our way to the reserve to Dave Cole's house. We all end up in his tiny lounge, where food has been prepared. Many people from the village drop in to see the South Africans. A First Nations MP tells us about settlements and land claims. A sculptor talks

about Levi Strauss's interpretation of North American First Nations. They ask us about South Africa. Many questions, much shared experience. Then we exchange gifts.

We have been told to bring gifts by our Canadian tour hosts as this is a First Nations custom. We hand over Ndebele beadwork and our hosts thank us in their polite, understated manner.

Then Dave Cole returns to the room holding a pile of books and some feathers. In his slow measured tones he tells us of the significance of gifts to travellers. "Gifts," he says, "in the old days were a form of economic exchange. If you give a gift to someone you expect twice in return." He then holds up the eagle feathers and talks of their significance. "Birds have always been important to us because they can go where they wish, they light where they may, and they're free. We take these feathers from the birds. We use them in our ceremony because the feathers remind us of the Creator. The eagle flies highest in the sky of all the birds and so he is the most sacred of all. He is the highest of all the birds and so belongs to all the tribes, all the people."

We are then each handed a book and an eagle feather. My book is a beautiful limited edition on First Nation folklore. Dave Cole has taken it from his personal collection. I feel quite emotional as we shake hands and depart.

It's dark and we drive past the humble houses in the reserve. I let the images of the day run by me. *If you give you must always expect twice in return.* This sentence rings through me. I am soon to return home to South Africa where communities face the same issues of poverty and lack of development. It really is a global challenge. How can I give back twice as much of the knowledge that I have acquired? ♦

Mining and indigenous peoples

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There have been significant changes to the relationships between Indigenous People and the mining companies. These mining companies have just begun to take the first necessary steps toward meaningful Indigenous Peoples involvement. Indigenous Peoples and mining companies can work together and achieve a win-win situation for both communities.

It is a myth that, in North America, Indigenous People only know how to do fancy beadwork and carve totem poles. Mining companies have begun to see Indigenous People in a new light, as potential partners and a ready labour pool; not only as a potential liability but also as a potential benefit to their projects. This can only bring about a positive result to all future relationships between these mining companies and the Indigenous People they encounter in their mining ventures.

Direct legislation, Indigenous control of their traditional territories, and court decisions are now a fact of life for the mining industry, and it must

be pointed out that these changes are taking place worldwide not just in developed countries. Therefore, any mining company that wants to mine or explore for minerals is going to have to deal with the Indigenous population in a significant manner. Musselwhite, Raglan, Red Dog and the Tampakan copper mine are a good starting points for future projects.

However, in many instances, the Indigenous view of "long-term" is still missing. To people who have lived in a region for 5 – 10 and even 20 thousand years, a mining project of 20 or 30 years duration is not considered long-term. A 20 or 30 year mining project is just considered a disruption in the flow of time, much like effects of an earthquake or major flood but a mine has the potential to be much more disrupting to their way of life. The effects of an earthquake or major flood pass very quickly and life will go on. But once a community has moved from the "bush economy" to the "wage economy" they can't turn back. This

potentially devastating issue must be addressed.

Indigenous People were there before any mining project started and will be there after the mining project has ceased. So it must be understood that Indigenous people are talking in terms of a "Sustainable Communities" not "Sustainable Development". In other words, what is going to be left for the Indigenous People once the mining project has closed. Will they be left with a diversified community, improved infrastructure, better schools, better medical facilities, and transferable skills or will they be left, as in the past, with just an environmental headache?

Many people assume that once a mine closes and the operations have ceased the skills that the Indigenous People learned will be transferred to other projects. This is probably true in some cases but definitely not in all cases. Most Indigenous People do not like to leave their home area to seek employment. Therefore, more planning must go into new and existing projects as to the after effects of the mine closure.

Future mining projects must address the following issues:

- ◆ What can be done now to ensure that the community will be sustainable after the mine closes?
- ◆ What industries can be started or existing enterprises expanded to fill the role of the closed mine?
- ◆ What skills will the Indigenous People need to meet the reality that the mine has closed?
- ◆ Who is going to be responsible for seeing that these questions or issues are addressed?

The answer to these questions will be the challenge of the future. ◆

Tailings and waste

Dissection of an accident: lessons learned and follow-up actions from Baia Mare

Introduction

On January 30, 2000, a breach in the tailings dam of the Aurul S.A. Baia Mare Company released an estimated 50-100 tonnes of cyanide, as well as heavy metals, particularly copper, into the Somes, Tisza and finally into the Danube Rivers before reaching the Black Sea. The impact of the dam failure included contamination and interruption of the drinking water in 24 locations affecting some 2.5 million people, massive fish kill, destruction of aquatic species in the river systems, and severe negative impact on biodiversity, the rivers' ecosystems, drinking water supply and socio-economic conditions of the local population.

Following requests from the Governments of Hungary, Romania and the Federal Republic of Yugoslavia, UNEP and the Co-ordination of Humanitarian Affairs (OCHA) convened a team of experts to investigate the causes of this accident and to make recommendations to prevent further accidents. The main conclusions and recommendations of the report are listed below.

Main Conclusions from the Assessment Report

- ◆ The breach in the retention dam was probably caused by a combination of inherent design deficiencies in the process, unforeseen operating conditions and bad weather.
- ◆ Tailings dams at operating mines are under continuous construction, as solid material and effluent (plus natural inflow due to precipitation) are added. Besides safe control of pond water volume under storm runoff conditions, the safety of the dam is mainly due to a sound balance between dam height and pond water level.
 - ◆ In the case of the new Aurul pond at Baia Mare, the flows of solids and waters were out of

balance with the increase of the storage capacity of the pond, as the process of dam construction could not keep up with the rise in the reservoir water level. The climatic conditions of the winter season aggravated the situation and led to an uncontrolled rise of pond level resulting in an overflow of the dam.

- ◆ The company responded by repairing the breach using borrow material from nearby, and by adding sodium hypochlorite to the overflow (and to the area flooded by the spill). A large volume of heavily contaminated effluent nevertheless escaped before the breach could be closed.
- ◆ There were no provisions for coping with situations of a rise of pond water level due to uncontrollable input into the reservoir system.
- ◆ The company was operating in line with Government permits. The plant was assessed as being of "regular" risk.
- ◆ No special monitoring or contingency planning at the premises of the company were required. Formal emergency preparedness and response procedures by the company and local authorities were rudimentarily considering the large quantities of hazardous materials (cyanide, hypochlorite) being used close to human populations and the river system. There appeared to be no monitoring system to detect the onset of dangerous situations. On and off site contingency plans existed but proved insufficient.
- ◆ The company took reasonable steps to respond to the emergency. It could not be determined how often the plant had been inspected by the government authorities before the spill occurred. However, the early warning system established under the Danube River Protection Convention responded adequately to alert neighbouring countries.

◆ The acute transboundary pollution had the potential of having a severe negative impact on biodiversity, the rivers' ecosystems, drinking water supply and socio-economic conditions of the local population.

◆ Timely information exchange and measures taken by the Romanian, Hungarian and Yugoslavian authorities, including a temporary closure of the Tisza lake dam, mitigated and reduced the risk and impact of the spill.

◆ Acute effects, typical for cyanide, occurred for long stretches of the river system down to the confluence of the Tisza with the Danube: phyto- and zooplankton were down to zero when the cyanide plume passed and fish were killed in the plume or immediately after. The Hungarian authorities provided estimates of the total amount of fish killed in excess of one thousand tons, whereas the Romanian authorities informed that the amount of dead fish reported was very small.

◆ Chronic effects due to the heavy metals could not be assessed during the UN mission and should be subject to future assessments.

◆ Villages close to the accident site were provided with alternative water sources, but were allegedly not informed about the spill sufficiently early.

◆ The spill occurred in an area already contaminated with heavy metals from a long history of mining and metal processing. Upstream locations unaffected by this particular spill also contained high levels of some heavy metals.

◆ The recent accidents in Baia Mare and Baia Borsa have dramatically increased public awareness of the environmental and safety hazards of the mining industry. The Baia Mare accident showed that the level of public knowledge and understanding of risks inherent in mining and related industrial processes is very low.

Key Recommendations from the Assessment Report

♦ A re-assessment should be made of the relationship between environmental "benefits and risks" of the mining scheme of the Aurul S.A. company. In particular, a risk assessment study should be carried out of the entire system of re-mining the old tailings.

♦ In this connection, special emphasis should be given to the following aspects:

- whether and how hydromonitoring of the material to be re-mined using cyanide – containing effluent can be avoided and replaced by an environmentally less risky process;
- whether processing of the materials in the plant can be done with less toxic materials.

♦ An inventory and risk assessment study should be made of all mining and related industries in the Maramures region, including abandoned sites, as a basis for better accident prevention and improved emergency preparedness and response measures.

♦ In order to ensure prompt early warning and response, the existing on and off-site contingency plans should be revised with the relevant partners. The organisational roles and responsibilities off-site for dealing with a dam breach and the ensuing water pollution should be clarified. The plans should be practical, targeted to the site and fully accessible by workers and local stakeholders.

♦ The sampling and analyses work was limited in time and scope. There is a need for:

- further analysis of the composition of the sediments in the new pond at Aurul to determine the amount and types of cyanide present;
- monitoring of water quality in the wells to identify any delayed contamination;
- monitoring of the long term ecological effects of the spill;
- agreement by all countries in the Tisza catchment area on a set of common baseline indicators for water and sediment quality monitoring, and improvement and harmonization of their monitoring systems.

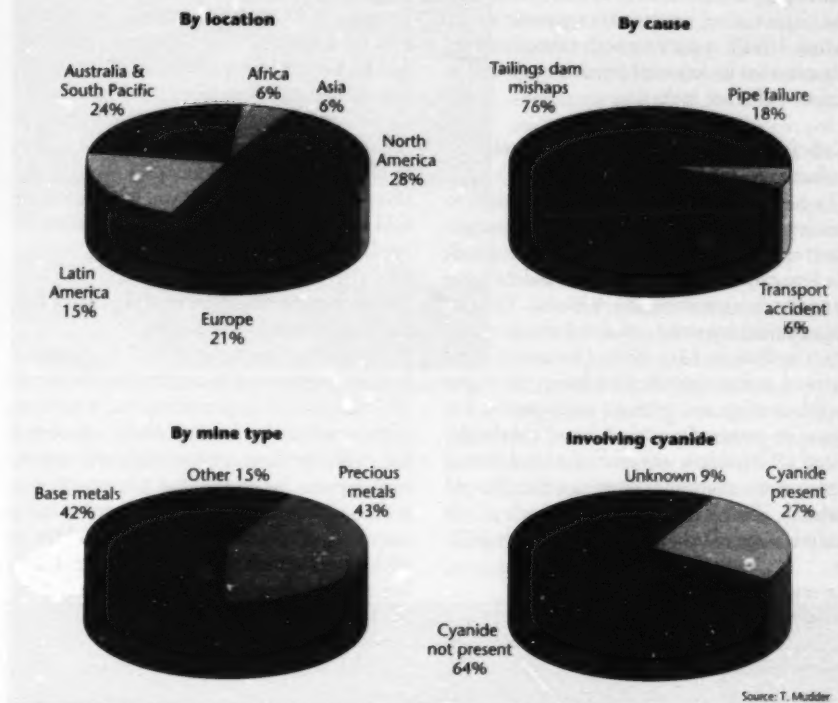
♦ In the light of a number of earlier accidents with tailing dams, it is advisable to review construction concepts and operation procedures related to enterprises using such dams, including concepts of secondary security or retention of spills at dams containing toxic effluents or other liquids. Also, more attention should be paid to better integrating the construction and operational aspects of the design.

♦ With respect to enterprises using cyanide, special attention is needed for emergency preparedness, emergency response and public communication measures (the APELL process), as well as special monitoring and inspection by the authorities.

♦ Process water ponds should, wherever possible, be reduced in quantity and to sizes which can be handled in emergencies. They should have retention systems for overflow or for accidents resulting from a break of the dam.

♦ In the Maramures area, consideration should be given to changing drinking water supply systems for private households to public / collective systems.

Summary of major mining-related environmental incidents since 1975



♦ Both in the case of acute emergency and with respect to longer term impact, much can and should be done to raise awareness and inform the local population along the Somes, Tisza, Danube rivers and in the catchment area as a whole, concerning the characteristics and potential risks involved at the mining and other industrial activities upstream. Unnecessary concerns and potential economic losses can be avoided with well informed local communities. Communications channels between the respective central government, the district and local authorities, should be optimized and NGOs and other interest groups, especially at the local level, should be mobilized and assist in informing the population and in providing replies to their concerns. The APELL process (Awareness and Preparedness for Emergencies at Local Level) would be an appropriate process on which to base such a programme.

♦ There is a strong need for a broad, longer term environmental management plan and sustainable development strategy for both the Maramures region in Romania and the entire catchment area of the Tisza river; a strategy which would address, inter alia, the mining and related industries, other economic activities (such as tourism and fishing), biological diversity requirements, and social needs and imperatives.

♦ UNEP and other relevant international organizations should pay special attention to promoting:

- emergency preparedness and response (APELL) in communities close to hazardous installations and mine sites;

- revised design and operating codes for cyanide processes at mines;
- development of new international standards for fail-safe concepts in tailings dams;
- publication of a 'best practices water management at mines' guide and case studies;
- a review of permitting and inspection procedures of hazardous mining installations;
- training workshops for national inspectorates in risk assessment and enforcement.

♦ UNEP and its partners should also continue the dialogue with the mining industry to review design and operation codes, and promote a review and consultations on governmental approval permits and inspection procedures related to mining operations.

♦ The Disaster Response Branch of OCHA and its Joint UNEP/OCHA Environment Unit should take appropriate steps to further develop the application of the concept of the UN Disaster Assessment and Coordination (UNDAC) to various environmental emergencies, including large-scale spills of mining tailings. The establishment of a small team of associated environmental experts should also be considered.

Accident prevention and emergency preparedness in mining : UNEP's follow-up initiatives

It is important to strengthen the focus on accident prevention and emergency preparedness at mine sites. The Baia Mare Report highlighted a number of causal factors. While many of these factors

have also been present in other tailings accidents, the experience at Baia Mare has led to a number of organisations, including UNEP, undertaking initiatives aimed at preventing, or at least lessening, the impact of such events as may occur in the future. UNEP is working with various partner organisations on key areas which are expected to make a difference in the future.

Code for cyanide management in the gold industry

The gold industry has signalled its intention to develop a voluntary global Code for the management of cyanide in mining. UNEP, working with the International Council on Metals and the Environment, is supporting this initiative. The two organisations convened a multistakeholder workshop in Paris in May 2000. Discussion commenced at that workshop on issues relating to scope, coverage and content, and a process was agreed to oversee the work. A broad stakeholder Steering Committee was established and there is widespread consultation occurring within the gold industry. There is strong support for such a Code and it is expected to be implemented in early 2002.

Emergency preparedness and disaster response

Adequate local awareness and preparedness for emergencies is necessary to ensure that the critical first response to an accident is rapid and effective. In the past, community consultation for integrated emergency response planning has not always occurred at mining and minerals processing oper-

ations. As one of the Baia Mare follow-up activities, UNEP and the International Council on Metals and the Environment held a joint workshop on Emergency Preparedness and Disaster Response in May 2000. Awareness & Preparedness for Emergencies at the Local Level – the APELL programme, provides a well established general methodology which UNEP is now tailoring to the specific characteristics and needs of the mining industry and its communities. A handbook for mining and minerals processing now being developed by UNEP will be reviewed and field tested with governments and companies during 2001.

Improving the effectiveness of regulation for accident prevention in mining

As regulators of the mining industry, it is incumbent on governments to examine the effectiveness of their approach to permitting and monitoring of those activities in mining, which, were they to fail, could have large environmental and community impacts. To assist in this process, the Australian Government and UNEP co-hosted an international workshop of regulators in October 2000. Government officials from some 25 mining countries reviewed emerging practices in regulation with a focus on the permitting of tailings facilities and the use of chemicals such as cyanide. Reviewing the lessons learnt from past mining accidents and comparing actions taken by governments to prevent their recurrence, it was acknowledged that national and international efforts on building appropriate skills to enhance

regulatory capacity and learning to identify early warning signs of impending accidents is needed to improve the effectiveness of regulation for accident prevention in mining.

Contingency engineering or "fail-safe" features for tailings storage facilities

If sound principles and practices are followed in the design, construction and operation of tailings facilities, there should be few accidents in the mining industry and hence little need to consider "fail-safe" or "back-up" features in the design and location of dams. However, the frequency of occurrences and potential consequences of dam failures indicate the need for thorough consideration of the potential which may exist for additional safety features to be integrated into the design of tailings facilities in order to minimise the impact of a dam accident. Working with experts on this issue, UNEP is calling together a targeted group of people to examine the range of available options, their benefits and costs, limitations and applicability.

Notes

¹ The full text of the Report, Cyanide Spill at Baia Mare, UNEP/OCHA Assessment Mission Report, April 2000 is available at www.natural-resources.org/environment/BaiaMare

² Information on UNEP activities is publicly available on the Mineral Resources Forum website at: www.natural-resources.org/environment



Tailings accidents and lessons learned

"Tailings Dams: Risk of Dangerous Occurrences: Lessons Learned from Practical Experiences" is the title of a Bulletin to be released by the International Commission on Large Dams (ICOLD) and UNEP. The "practical experience" is presented in the form of a review of some 230 tailings dam accidents over the past 50 years, together with examples of effective remedial measures. The Bulletin aims to highlight some of the dam failures commonly encountered so as to avoid similar difficulties in future as these failures have been costly to both life and the environment.

The Foreword to the Bulletin describes the

challenge:

"The disposal of wastes in our overcrowded world has become a serious problem. Due to the nature of mining and mineral processing, the volumes of mining wastes are significantly larger than those of both domestic and industrial wastes. The chemical characteristics of the waste (particularly mobility of metal constituents) are often of concern. The volumes of mine wastes greatly exceed the total volumes of materials handled by civil engineering throughout the world. The crushed rock passed through the processing plants to extract the desired product is discharged from the 'tail end' of the plant as the waste tailings,

and in many parts of the world forms the greatest volume of mine waste, although at open-pit mining operations the volume of waste rock may exceed the volume of tailings. The fine particulate tailings are commonly stored in impoundments retained by tailings dams. The material is placed hydraulically and so is loose and nearly saturated. Any major movement of the retaining walls of the impoundment can induce shearing strains that disturb the structure of the tailings mass, inducing a rapid rise of pore water pressures and liquefaction of a section of the impoundment, causing even greater pressures to be applied to the retaining walls. Failure of the retaining dam can release liquefied tailings that can travel for great distances. Water will flow through and around buildings, but liquefied tailings, due to their greater weight can destroy the structures. The increasing size of modern mines means that tailing dams are becoming ever higher and impoundments even larger.

Similarities between tailings dams and embankment dams designed to retain water, have enabled many of the design techniques used with embankment dams to be applied to produce safe tailings dams, but

despite great improvements, there has been a reported failure of a tailings dam almost every year for the past two decades. The damage caused by these failures in terms of human casualties, destruction of property, disruption of communications, pollution of the environment and economic loss to the mining industry is enormous. The purpose of this Bulletin is to discuss some of these failures and see what lessons can be learned from them, to identify improvements that would reduce the occurrence of these failures."

Knowledge about the factors that control the behaviour of tailings dams has improved greatly during the past 20 years. Detailed guidelines for the safe design and construction of tailings dams and waste lagoons have been published and the consequences and public awareness of tailings dam failures have increased considerably, causing managers and owners to become more aware of the risks involved in the construction of impoundments. Nevertheless, although the percentage of recorded failures has decreased over the past decades because of the improved understanding of the behaviour of dams and the improved methods of design and construction, the number of incidences (14 between 1990 – 2000) remains unacceptably high. Many factors influence the behaviour of tailings impoundments; accidents and other incidents are often the result of inadequate site investigation, design, construction, operation, or monitoring of the impoundment, or some combination of these.

At the design stage, attention must be paid to those critical features that can affect the long term safety of a tailings dam. Sound fundamental design pays dividends throughout the life of the dam. ICOLD and others have published many technical guidelines for the safe design and construction of tailings dams and waste lagoons. However, ICOLD is increasingly warning that to keep a tailings facility in a safe condition throughout its life, overall management and the practical application of knowledge is critical. Sound design must be followed by appropriate management, plus regulation that effectively targets ongoing operational safety over the life of the facility – and beyond.

ICOLD and UNEP have drawn the conclusion



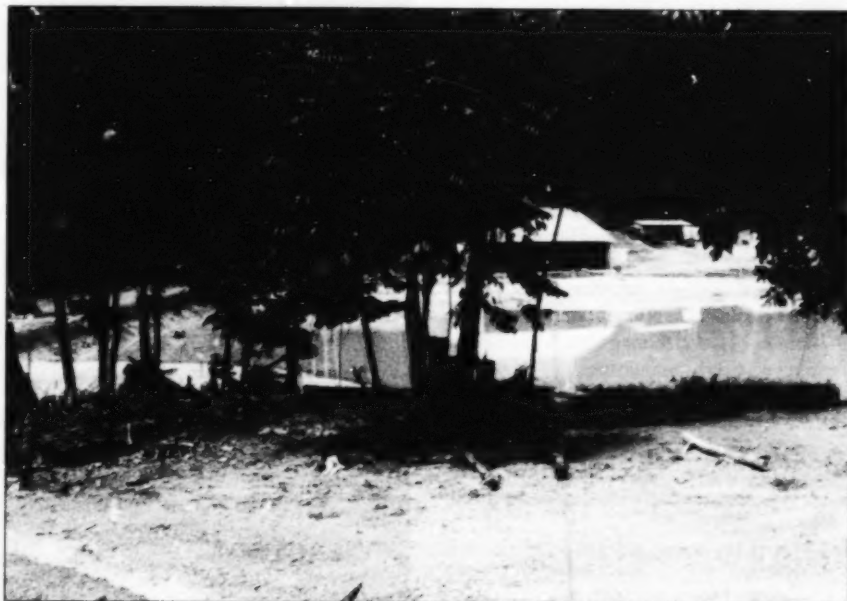
Venezuela: environmental damage from artisanal mining activity

from recent accidents that the vital efforts on prevention must be supplemented by additional attention to risk reduction and mitigation to reduce not only the frequency, but also the severity of accidents which do occur. Emergency preparedness should also be part of the total picture

of responses to the continuing contemporary accident record.

Every site and dam is unique and there needs to be more attention paid to risk assessments in each individual case, leading to tougher decisions about whether the presence of certain risk factors can be adequately addressed through siting or design or other means. UNEP has posed the question as to whether in some cases there may also be scope for incorporating additional measures through engineering, siting or contingency structures, to reduce the energy or deflect the impact in the event of a failure.

The Bulletin on Lessons Learned is intended to give advice, drawn directly from experience, that can help those responsible for impoundments and tailings dams. Learning from errors is vital for improving knowledge and promoting improvements and it is in that spirit that the Bulletin will be published early in 2001. It is only one in a series of initiatives being taken in the tailings area with the aim of making a difference to their safety and environmental record. ♦



Silviculture project for area rehabilitation: Las Cristinas, Venezuela

Emergency preparedness and response: APELL for mining

Recent accidents – including that at Baia Mare in Romania in January 2000 – have focused attention on the fact that mines can be dangerous to the public as well as to those at the mine site. We have also learned that emergency response procedures are deficient and that public understanding of mine related threats is low. This misunderstanding often leads to fear and adverse reaction to mining developments.

Emergency response is a multi-stakeholder activity that requires extensive preparation and determined execution. Not all industries understand the full extent of the public communication challenge that is involved.

Awareness and Preparedness for Emergencies at Local Level (APELL) is a process which has been developed by the United Nations Environment Programme in conjunction with communities, governments and industry. APELL was prepared in response to various industrial accidents in both developed and developing countries which have resulted in adverse impacts on the environment and on local communities. The purpose of APELL is to prevent, prepare for and respond to technological accidents and emergencies.

While major accidents are not frequent given the number of global mining operations, they are continuing to occur with unacceptable regularity. In addition, the industry has in a sense been lucky that few lives have been lost in adjacent communities as the result of accidents in recent years. The next major accident could reverse that unless measures are taken to minimise risks and plan for effective action.

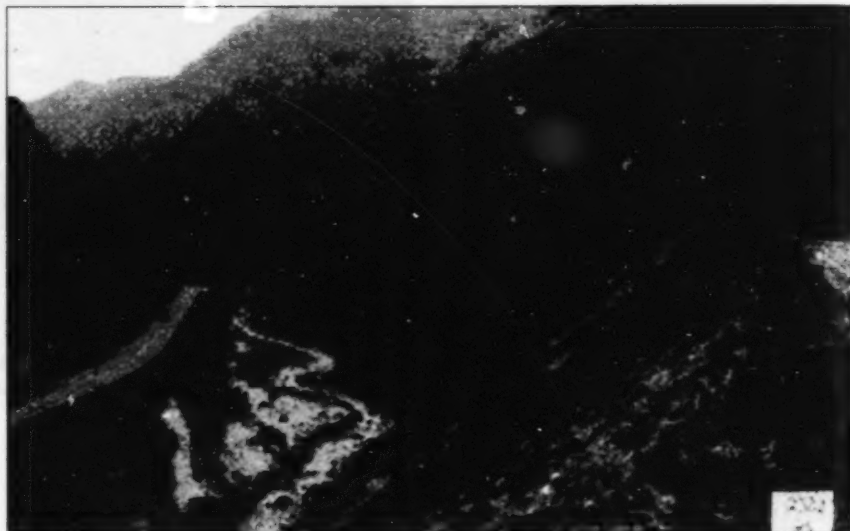
Although the aim of accident prevention and safe operation must remain paramount, UNEP urges the pragmatic approach of preparing for emergencies as they may happen despite safe design proactive and sound procedures being followed. Promoting use of APELL by the mining industry is therefore one of UNEP's priorities to improve contingency planning in the industry.

Mining industry emergencies: the case for APELL

Mines and mineral processing facilities are often large, multifaceted operations in unique locations, with very specific interactions between communities and the environment. Over the last 25 years there have been some 33 major accidents worldwide resulting in releases to the environment.⁵ Of these, 7 incidents involved fatalities; a total of 326 people have died, 268 in one accident at Stava in Italy in 1985 as a result of a pipe failure at a fluo-



Peru: tailings dams in Rimac River Valley



rite mine. Of the remaining fatalities, 7 occurred in Brazil in 1986 as a result of a dam failure, 20 in 1988 in China, 17 at Merrespruit, South Africa in 1994 from an overtopping failure and 12 in the Philippines in 1995.¹ An October 2000 tailings dam failure at a mine in China has left ten dead and over 100 unaccounted for when a mine hostel and local houses were engulfed by tailings. In the latter part of 2000, a number of well publicised incidents at or near mine sites again raised

the awareness of mining as an industry in which incidents may result in severe off-site damage, including effects on local communities. The April 2000 UNEP/OCHA Assessment Mission Report on the Baia Mare Tailings Accident highlights the fact that public knowledge and understanding of risks inherent in mining and related industries is very low. It also reported that, in the case of a spill, there is frequently insufficient communication between the industry, various authorities and

between NGOs and the public concerning emergency preparedness, emergency response and measures to limit damage should an accident occur.

Like all industrial sectors, the mining industry has risks specifically related to its operations. Some risks are similar to those in other industries, such as storage, handling, transportation and the use of toxic chemicals. Hazardous materials are used at most mining and mineral processing operations, and many waste products generated by these operations and stored in specially designed facilities at mines can be hazardous to human health and the environment.

Risks from tailings dams have drawn particular attention, following failures at mines in Europe and elsewhere. In August 1995, a tailings dam at the Omai gold mine in Guyana, South America failed, spilling water containing cyanide from the tailings dam into one of the country's main rivers. At Los Frailes in Spain, the wall of the tailings impoundment failed in April 1998, releasing around 5.5 million cubic metres of acid water and 1.5 million tonnes of tailings from the polymetallic mine into the local river and floodplain system.² Farmland was inundated, wells were contaminated and the Doñana National Park, a World Heritage Site and also a RAMSAR site was threatened by the resulting pollution. In January 2000, a spill at Aurul SA Baia Mare gold mine, a site in Romania reprocessing tailings, caused extensive water pollution and fish kills in the Tisza and Danube rivers, crossing national boundaries into Hungary and the Federal Republic of Yugoslavia.

While accidents involving facilities or activities other than tailings disposal do occur, they appear to be generally less frequent. However, they still have the potential to cause serious environmental and health effects. A review of gold industry incidents since 1975 reveals 72% of the incidents involved tailings dams, while 14% involved pipe failure and 14% transport accidents.³ For example, in May 1998, a truck carrying cyanide to Kumtor mine in Kyrgyzstan overturned, spilling cyanide into the river. Another example involving the transport of cyanide to a site is that of a tonne of sodium cyanide pellets falling from a helicopter en route to Tolukuma mine in Papua New Guinea in March 2000, and landing close to a stream. In June 2000, a truck carrying mercury, a by-product of the mineral processing at Yanacocha gold mine in Peru, spilled around 200 kilograms of mercury from an opened flask as it passed through a number of villages. Only 66 kilograms of the mercury was recovered, and several hundred people were treated in medical centres and hospitals as a result of exposure to fumes and from direct contact with the mercury.

What is APELL?

APELL provides a step-by-step description of how to develop an integrated and functional emergency response plan for local communities. APELL identifies and creates awareness of risks in communities living close to industrial facilities, initiates measures for risk reduction and mitigation,

and develops preparedness for emergencies involving industries, local governments, and communities. APELL is comprised of a ten-step approach to carrying out this process which was originally developed with large industrial operations in mind. Adapted so far for port facilities and the transport industry, a Handbook for APELL for the mining industry is expected to be released in 2001.

How is APELL relevant to the minerals industry?

The minerals industry is diverse – sites may be found in all parts of the world, in all climatic zones, extracting a variety of different minerals and metals, using different mining methods, different processing routes, different chemicals and producing different end materials and wastes. Yet there are also common features and similarities between sites. Most sites use chemicals or processes or produce materials that have the potential to cause off-site incidents and therefore the APELL process can be applied to them.

The table below gives examples of the sort of accidents which are possible. Many of these have actually occurred in the industry, but not all have. Some of them however have occurred in other industries. In mining most major accidents with offsite impacts have been tailings accidents. The possibilities are not raised to be dramatic or to fuel fear of the industry, but in the interests of thoroughness for contingency planning purposes.

What is the APELL process?

APELL's overall goals are to prevent loss of life or damage to health and social well being, ensure environmental safety in the area surrounding and avoid property damage by promoting community preparedness.

APELL for the mining sector has two overall goals. First, the process creates/increases community awareness of the possible hazards involved in the production, transport, handling, use and storage of hazardous materials including tailings, waste rock and chemicals, and the steps taken by authorities and the company to protect the community from them. Secondly, there is a need to develop, or improve, on the basis of this information, and in co-operation with the local communities and emergency providers, effective response plans involving the entire community, should an emergency arise.

The specific objectives of the Process are five-fold, namely:

- ◆ Communicate with potentially affected members of the community on the hazards involved in mining and mineral processing operations in their neighbourhood and the measures taken to reduce the resulting risks;
- ◆ Review, establish or update emergency response plans in the local area;
- ◆ Increase company involvement in community awareness and emergency response planning;
- ◆ Integrate company emergency plans with local emergency response plans in one overall plan for the community, to handle different possible emergencies; and
- ◆ Involve members of the local community in the development, testing and implementation of the overall emergency response plan.

The 10 APELL steps

The APELL process has been designed along ten steps which are outlined below:

- ◆ Identify the emergency response participants and establish their roles, resources and concerns;
- ◆ Evaluate the risks and hazards that may result in emergency situations in the community;

Potential accidents associated with mine sites and their effects

Type of Incident	Typical Causes	Effects on communities
Tailings dam failure	Piping, overtopping, foundation failure, erosion, earthquake.	Loss of life, water supplies, contamination of wells, destruction of aquatic habitat, loss of crops and contamination of farmland, threat to protected habitat and loss of livelihood
Failure of waste rock dump.	Stability often related to water, such as springs, poor dump drainage	Loss of life, injuries, destruction of property, damage to ecosystems and farmland.
Spills of toxic chemicals en route to/from site.	Inadequate transport procedures and equipment. Unsafe packaging	Contamination of soil, water, effects on water users, aquatic ecosystem damage.
Release of chemicals from tailings dams	Overtopping, piping breaks, foundation failure (see above)	Loss of food and water supply in subsistence areas, fish kills impacting livelihoods, destruction of ecosystems, increased community concerns
Subsidence	Slope failure, breakthrough to surface	Loss of life, damage to property
Spills of chemicals at site e.g. fuel tank rupture, reagent store damage	Poor maintenance, inadequate containment.	Contamination of soil and water, poisoning of water users. Air pollution could have health effects.
Fire	Poor design, poor maintenance and operation	Effects of air pollution on health, property damage
Atmospheric releases	Inadequate design, failure to follow procedures, inadequate maintenance.	Community concern, possible health effects.
Explosions (plant)	Inadequate design, failure to follow procedures, inadequate maintenance.	Community concern, loss of life, destruction of property.
Blasting and explosives accidents	Poor practice	Property damage, risk to life

- ◆ Have participants review their own emergency plan for adequacy relative to a coordinated response;
- ◆ Identify the required response tasks not covered by the existing plans;
- ◆ Match these tasks to the resources available from the identified participants;
- ◆ Make the changes necessary to improve existing plans, integrate them into an overall community plan and gain agreement;
- ◆ Commit the integrated plan to writing and obtain approvals from local governments;
- ◆ Communicate the integrated plan to participating groups and ensure that all emergency responders are trained;
- ◆ Communicate the integrated plan to the general community.

When UNEP first developed the APELL process, it was recognised that various countries differ in culture, value systems, community infrastructure, response capabilities and resources, and in legal and regulatory requirements. Given the variety of local situations that exist, the APELL steps provide the basic concepts for the development of action plans based on local community awareness of potential dangers and the preparation of unique emergency response plans. While the objectives remain unchanged, the mechanics of the development and operation will change from place to place, in accordance with specific local conditions and requirements.

Scope

Large and small mining operations should be equally concerned with community involvement in contingency planning and being fully prepared for emergencies, but it is likely that there is a certain size of mine below which APELL would be difficult to implement. Although small scale and artisanal mining operations have the potential to cause off-site damage, particularly when they are highly concentrated in a relatively small area,⁴ the organisation and resources required to move through the APELL process would be lacking. In some areas, however, some of the activities of artisanal miners are becoming centralised through co-operatives designed to increase recoveries, improve

safety and reduce impacts to the environment, and where these schemes are operating successfully, introducing the APELL process to the co-operative group may be feasible.

The Benefits of Implementing APELL

Mining companies have become much more transparent and proactive in their relationships with stakeholders. This is in recognition of the legitimate interests of local communities, not only in the employment and business opportunities generated by the presence of a mine in their area, but also in the environmental and social impacts and pressures which it can bring. Communities have a right to know what they are exposed to and increasingly they expect to be consulted and, if they have well-founded concerns about certain aspects, to have an influence on the way operations are managed.

Companies understand that support for or opposition to a mine from civil society and communities can be highly influential in decisions about whether and under what conditions a mine can operate. They therefore need to establish trust and support based on effective two-way communication with local communities and other stakeholders.

Trust, support and an understanding of the operation amongst the local community will be severely tested if there is a major accident with potential or actual off-site impacts. If trust exists, the company will be better placed to communicate effectively in the case of an emergency as well as to recover more quickly from one. If a base of awareness and trust does not exist, the consequences of an accident for the company will certainly be worse and more long-lived.

The APELL process should bring benefits in at least three ways:

- ◆ to reduce the risks of accidents and to reduce the impacts of accidents as a result of the process of hazard and risk identification, risk reduction and risk communication undertaken
- ◆ to help build relationships between the mine and the community which will be of benefit over the long term
- ◆ to assist awareness and understanding of the

operation and its management which should generate the confidence, trust and support which companies need whether or not they experience an accident.

Mining companies and management have many important priorities which compete for attention and resources. How important is APELL in the scheme of things for companies? Individual companies will make their own decision about that, but they will no doubt take into consideration that accidents and their consequences, though rare, do happen with potentially disastrous consequences; that a mine is often part of a community for a generation or more and is often the dominant operation in that community; and that the industry is coming off a base of having a trust and a knowledge deficit. These considerations should make APELL an option worth pursuing.

How APELL could have made a difference

As an example where the effects of an accident may have been significantly reduced had local communities been more knowledgeable because of their involvement in an APELL process is the Yanagocha case in Peru. 200 kilograms of mercury spilled from an open flask on a truck as it passed through a number of villages en route from the Yanagocha gold mine. Only 66 kilograms of the local material was recovered. As well as using it in local medicine, the local people believe that the mercury contains gold. Many therefore heated the mercury in their homes, with little ventilation to "obtain the gold". As a result, several hundred people were treated in medical centres and hospitals as a result of exposure to toxic mercury fumes. In this case, had an effective communication program regarding the hazards and potential health effects arising from contact with mercury been conducted, it could have influenced behaviours and health impacts should not have arisen.

Notes

¹ T. Mudder and M. Botz

² Eriksson and Adamek, 2000

³ T. Mudder and M. Botz

⁴ such as at Serra Pelada in Brazil

The case for auditing and certification of tailings management facilities

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Abstract

A quick review of tailings dams that have failed in the past 25 years indicate that many have occurred in under-regulated environments. The major driving force in reducing the number of tailings dam incidents is the adoption of regulations requiring independent auditing and facility certification, and recognition of the need for a competent person with experience in tailings management facilities.

Résumé

Une étude rapide des bassins de retenue de résidus qui se sont rompus au cours des vingt-cinq dernières années montre que beaucoup de ruptures se sont produites dans des environnements sous-réglementés. Le meilleur moyen de réduire le nombre d'accidents est d'adopter des règlements exigeant l'audit et la certification des installations par un organisme indépendant et de reconnaître la nécessité de confier les installations de gestion des bassins de retenue à une personne compétente et expérimentée dans ce domaine.

Resumen

Un rápido análisis de las represas para decantación de desechos mineros que han sufrido desperfectos en los últimos veinticinco años indica que muchas de estas fallas ocurrieron en ambientes con reglamentación insuficiente. El factor principal para reducir el número de incidentes en las represas para decantación de desechos mineros es adoptar normas que exijan auditorías y certificaciones independientes y reconocer la necesidad de contar con una persona competente con experiencia en plantas de tratamiento de residuos mineros.

Introduction

As the volume of waste material produced in the world increases, efforts to minimize the waste produced or to store it in both an environmentally sound and well engineered manner are essential. This process is especially important in the mining industry where increased worldwide demand, lower ore resource grades and increased equipment capacity has led to higher tonnages and rates of throughput at many mines. These increases have placed great demands both on the design and operation of waste rock dumps and tailings management facilities.

The reputation of the mining industry has been damaged recently by a number of high profile tailings dam incidents that have dented confidence in the storage process. This article seeks to review existing procedures in place for auditing and certification of tailings management facilities and suggests a regime which would increase public confidence.

It is important to note that many of the regulations and laws that have been put in place have been in reaction to an incident that has raised public concern. The industry should therefore not wait until a severe failure occurs before putting acceptable procedures in place.

Existing regulations

Most countries in the world have developed their

own mining regulations to cover both underground and surface extraction of minerals and often, but not always, the processing of the ore/aggregate. Legislation – originally developed to ensure the health and safety of workers, together with the associated regulations – has been modified as planning, health and safety and environmental requirements have changed. For instance, the Mining Act in the UK dates from the mid 19th Century and has been successively modified and adapted for both metalliferous and coal mining as developments in both mining technologies and health and safety requirements have progressed. The same legislation remains in force in the UK today, but strengthened and supplemented by a range of additional legislation to meet the needs of a modern mine and to cover all aspects of the extraction industries from methane generation in coal mines to statutory inspection of mine waste tips and tailings lagoons. There are similar examples of mining laws being updated and modernized in Europe. However, what is clear is that, despite its origins, current mining legislation ranges from providing guidance on general mining health and safety issues to generic guidelines for the extraction of minerals from surface and underground operations. Evidence of specific legislation for mine waste rock dumps and tips or for tailings disposal facilities and lagoons is very limited in extent. There are few countries

which have specific regulations covering these aspects.

Early legislation does not include reference to either waste rock tips or tailings dam lagoons. In fact, in the UK, the latter were assumed to be covered in the Reservoirs (Safety Provisions) Act 1930 if such a facility, i.e. the tip or lagoon, was capable of containing more than 5 million gallons (22 600 m³) of water above ground level. Such a tip would then be inspected under the Reservoirs Act and primarily with respect to control of water rather than control of the solid fraction. It is clear that in Europe similar practices have been adopted and continue. For example, Portugal adopted a similar approach when the first modern tailings management facility was developed and the tailings dam was permitted under existing Portuguese reservoir legislation. Unfortunately, this has led to a number of anomalies because of the prescriptive nature of the act with regard to both design and operational features of the facility and due to the lack of regulations pertaining to solid waste disposal.

It is believed that the first legislation specifically associated with mine tips and tailings lagoons was developed in the UK following the 1966 Aberfan disaster. The legislation was crafted by a group of individuals with experience both of mining tips and geotechnical engineering and was specifically aimed at addressing the problems of tailings lagoons and waste tips and their continued security and safety. The legislation was drafted to form an extension of the Mines and Quarries Act 1954 and accordingly the Mines and Quarries (Tips) Regulations 1971 were passed. The regulations were designed to provide guidance to permitting authorities and to operating companies with regard to requirements for design and management and incorporated the need for expert audit and reporting on all tailings dams and tips during all the stages of development, including commissioning, operation and closure.

The table on the following page shows the general requirements under the Act with regard to the auditing process.

The Regulations indicated that the audits had to be undertaken by a competent person, but the precise qualifications of that person are ill-defined. However, the Health & Safety Executive, during the years of enforcement, has tended to ensure that, for the most part, the people undertaking the audits are indeed competent. The link with the UK reservoirs act has also continued, in that many of the competent people with regard to tailings

dams have also been appointed under this act. The Act and associated Regulations were further strengthened when the Reservoirs Act 1975 specifically excluded tailings dams and recognized the specific technical problems associated with mining-related containment structures. This Act and associated Regulations have been incorporated into existing legislation or used as the basis for new regulations in other countries.

Following the Mufulira tailings inrush disaster in Zambia in 1970, the Mines and Quarries Act was incorporated into the Mining Act in Zambia and formed the basis for regulations for the inspection and management of waste tips, water dams and tailings dams on mining properties. Similarly, the UK based legislation was also adopted in Malaysia in formulating its regulations for the management of tips and tailings dams, particularly associated with the tin mining industry. It is believed that this legislation has been the basis of a number of similar local regulations with regard to the control, operation and maintenance of tailings facilities and their regular inspection.

It is noted that the Act has successfully regulated waste tipping and tailings disposal and prevented any fatal occurrences due to strict enforcement by the Health & Safety Executive. Moreover, the Act is seen as having had significant benefits for the mining industry, governmental bodies and planning and permitting authorities in ensuring the preparation of regular independent audit reports from competent persons throughout a facility's operational life. More importantly, from an environmental perspective, the requirement for continuation of these audits post closure, indeed until the deposit or tip has been fully rehabilitated and become benign, was also defined.

A further significant aspect of the UK regulations, which has been repeated in other countries, is the formal appointment of competent persons to supervise the planning and design, undertake the auditing and certify the facilities.

Corporate policy

In the last 10 to 15 years major mining companies have taken a responsible attitude and have seen the corporate benefit of developing a policy that ensures compliance with appropriate engineering and environmental standards for their tailings facilities worldwide. In particular, as a result of a number of high profile tailings dam incidents, major mining houses have developed expert teams to undertake independent auditing of all their facilities regardless of the legislation under which they were constructed. More recently smaller mining companies have also adopted a similar policy of ensuring that regular auditing of their facilities is undertaken. These audits have often been instigated as a result of financial reviews or restructuring. Financial institutions require their investment in projects to be protected and, as tailings management facilities represent a major risk, auditing is often specified.

Permitting

There has been a significant change in the planning and permitting requirements for tailings

Section 9	Procedures before beginning tipping operations
	1a Geological map of site and boundaries at appropriate scale.
	1b Geological section of the strata underlying intended tip.
	1c Accurate plan of mine facilities at appropriate scale.
	2 Tipping report which includes: • total and annual amount of waste to be deposited; • site investigation details; • site preparation; • plans and cross sections of the depository; • method of tipping; • inspection and monitoring routines.
Section 12	Active classified tips require a report from a competent person on the tip and every matter affecting security of the tip every two years.
Section 18	Closed classified tips require a report from a competent person on every matter affecting security of the tip every five years.

management facilities, particularly in North America, Europe and Australia, primarily as a result of concerns with regard to closure and the premature abandonment of facilities which then remain unremediated and lead to environmental blight. As a result of this requirement planning authorities are increasingly resorting to bonding at permitting stage, primarily to ensure that premature closure of a mine would not lead to unremediated tailings management facilities or to mining companies abandoning a site on mine closure. Such bonding has primarily targeted closure and environmental remediation, but has also required the preparation and regular updating of closure plans and external auditing of the facility to ensure that it can be closed in accordance with closure requirements. Again this has led to mining companies being required to carry out audits on the facility with regard to closure. However, these tend not to be on a regular basis and therefore are of less benefit in ensuring ongoing safety and integrity of the facilities throughout their operational life. Such arrangements do ultimately require that, post closure, the facilities are monitored on abandonment and that the safety, security and environmental performance of the facilities are monitored on a regular basis post abandonment. These bonding arrangements also avoid "walk away" and the adoption of a passive care approach which inevitably leads to companies undertaking regular monitoring of the facility to ensure that as soon as a facility becomes benign they can transfer their responsibilities and minimize their long term liabilities.

Best practice

Experience of a wide range of systems for inspecting and auditing of tailings management facilities around the world indicates that where policies for regular expert auditing by competent persons have been enforced, failures have been reduced and incidences of untoward discharges have been significantly reduced. However, where legislation has remained under local water regulations it is clear that a number of problems remain due to the different approaches appropriate to water reservoirs and tailings dams. Such legislation has therefore been found wanting. Where no legislation exists, the risk of poor management practices and of failure, leading to untoward events, is greatly

enhanced and a quick review of those failures which have occurred in the last 25 years indicates that a number have occurred in under-regulated environments. The major driving force in reducing the number of tailings dam incidents is, firstly, the adoption of regulations that require regular independent auditing and certification of a facility and, secondly, the recognition of the need for a competent person to undertake the audits, and that the competent person must have experience of tailings management facilities, rather than having general competence in water dams or civil engineering.

A way forward

To restore public and industry confidence in tailings management facilities it is clear that a formal auditing regime leading to regular certification needs to be put in place. Many of the processes already exist in legislation, but are fragmented and not presented as a single coherent policy. However, it is clear that although a framework already exists it is inconceivable that identical legislation could be passed in all countries where mining occurs. The industry could, with appropriate support, prepare relevant and workable guidelines for mining companies and regulators alike, based on existing and well proven legislation. Important features which should be incorporated in such guidelines could be:

- ◆ Definition of a competent person;
- ◆ Definition of risk categories;
- ◆ Frequency of inspections for different classes of risk;
- ◆ Highlighting of the importance of continuity of supervision;
- ◆ Emphasizing the need for accurate and long term record keeping;
- ◆ Attempting to define the regulatory authority;
- ◆ Provision of guidance on relevant engineering and environmental standards and reference appropriate documents;
- ◆ Specification of the need for operator training;
- ◆ Encouraging high safety standards and a consistent approach.

The question remains as to which bodies might be sufficiently authoritative and acceptable in the international arena to produce suitable guidelines. For example, the European Commission (EC) has drafted the landfill directive which, in the absence

of local relevant mining legislation, has been proposed as the pan-European standard for tailings management facilities, but it does not include guidance on auditing procedures. Similarly, the EC is also currently considering including "tailings ponds" in the Seveso II Directive [92/082/EEC]. Neither approach is likely to be acceptable internationally, due primarily to the generic and non-mining basis of the legislation. A combined ICOLD/UNEP/ICME document would be more likely to represent an acceptable route, if based on

existing best practice and published bulletins. This is suggested as a topic for discussion.

It is appreciated that even if draft guidelines are produced quickly, international recognition and acceptance may still take several years. The early implementation of such guidance by industry is considered to be extremely important for creation of public confidence, and to Governmental and non-Governmental bodies so that tailings management facilities can be designed and constructed to be safe, stable and environmentally

appropriate repositories for mine waste both during operation and post closure. In the present climate, and until such guidelines have been implemented, it is incumbent upon industry and regulators to ensure that all those involved with tailings management facilities are competent and that high standards for design, construction, auditing and operating are maintained throughout the life of a depository. Without such an approach future mine permitting may be extremely difficult, if not impossible. ♦



Prevention of hazards in mining tailings dams and waste heaps

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Abstract

Low metal prices, fluctuations in foreign currency exchange rates and high labour costs have caused closure of many mines in Japan. According to MMAJ records, there are about 5,500 abandoned mines in Japan, and only 13 still in operation. This article discusses the current situation of hazard prevention in mining waste heaps in Japan and presents a case study of an active mine.

Résumé

Le prix extrêmement bas des métaux de base, les fluctuations du taux de change des devises étrangères et les coûts de main-d'œuvre élevés ont entraîné la fermeture de nombreuses mines japonaises. Selon l'Agence japonaise des mines de métaux (MMAJ), il y aurait au Japon environ 5 500 mines abandonnées et seulement 13 encore exploitées. L'article expose la situation actuelle au Japon en matière de prévention des dangers présentés par les terrils de déchets miniers, avec un cas d'étude concernant une mine encore en activité.

Resumen

Como consecuencia de los bajos precios de los metales, la fluctuación de los tipos de cambio de las divisas extranjeras y el incremento de los costos laborales, muchas minas en Japón han cerrado. De acuerdo con registros de la Agencia de Minería de Japón ((MMAJ)), existen alrededor de 5.500 sitios mineros abandonados en Japón y sólo 13 minas continúan funcionando. Este documento analiza las medidas de prevención de riesgo que se aplican actualmente a los desechos en Japón, mediante el estudio casuístico de una de sus minas activas

Hazards in mining waste heaps

Because mining wastes generally contain heavy metals, even a small-scale accident can cause great damage to the environment. Destruction of tailings dams due to natural disasters such as earthquakes or storms can result in the release of large amounts of tailings and may pose a serious risk for both humans and the environment.

In 1954, the "Standard Regulations for Construction of Mining Waste Heaps" were established, based on a worldwide standard for construction of waste heaps produced by the International Conference on Dams. In 1959, 1973 and 1980, provisions for "design to prevent liquefaction caused by earthquakes" were added to the regulations. In 1982, provisions for "management of mining waste

heaps" were amended.

This article explains the main hazards that have caused accidents in the past and the measures recommended in Japan to prevent them.

Types of mine hazards

The main types of hazards are:

(1) Release of mining wastes and dam-filling materials caused by heavy rains, snow and storms. This can happen when:

- ◆ inadequate routine maintenance of the drainage facility beyond the mine site allows the drainage system to become clogged by driftwood or collapsed soil; water from beyond the site can then flow in and cause the tailings dam to overflow;
 - ◆ the mine site's drainage system is clogged by driftwood causing build up of water which flows over the tailings dam;
 - ◆ the surface of the tailings dam is shaved (due to heavy rain or snow);
 - ◆ the tailings dam collapses due to elevated levels of seepage water;
 - ◆ insufficient capacity and inadequate monitoring of the drainage facility lead to inflow of water to the mine site resulting in overflow of the tailings dam;
 - ◆ tailings dams are destroyed by river flood water seeping into the bottom of the dam.
- (2) Release of mining waste due to damage to the underground tunnel.
- (3) Release of the mining waste caused by the phenomenon of *piping*.
- (4) Failure of the dam caused by earthquake.

Table 1
Items measured and frequency of measurement

	Mine in operation		Closed mine	
	In use	Finished	In use	Finished
Rain	Every day			
Seepage water level	Every month	Every six months	Every three months	Every year
Pore water pressure	As required	As required	As required	As required
Deformation	As required	As required	As required	As required
Settlement	As required	As required	As required	As required
Level of hydration and permeation of water	As required	As required	As required	As required

(5) Damage to the dam because of piping and the elevation of seepage water level, allowing inflow of water from the dam's soil.

Main causes of accidents in the past

According to a survey conducted by the Department of Mine Safeguards, 264 accidents occurred in mining waste heaps between 1930 and 1978. The causes of these accidents were:

- (1) Storm (heavy rain): 169 cases;
 - ◆ clogging of the drainage system by driftwood and collapse: 62 cases;
 - ◆ shaved surface of tailings dams and collapse of the tailings dam caused by increased levels of seepage water: 24 cases;
 - ◆ insufficient capacity and monitoring of the drainage system: 6 cases;
 - ◆ other damage to underground: 77 cases.
- (2) Storm-related ground tunnel: 20 cases.
- (3) Piping phenomenon in the dam: 13 cases.
- (4) Failure or partial failure of the dam caused by earthquake: 10 cases.
- (5) Other identified causes: 43 cases.

(6) Unknown causes: 9 cases.

Measures for prevention of mine hazards

For the main causes of accidents, described above, the following points should be stressed:

Storm (heavy rain)

While 64 per cent of all of the accidents were caused by continuous heavy storms, 37 per cent resulted from clogging of the drainage system.

At present, heavy storms caused by abnormal climate are the most frequent hazard causing clogging of the drainage system by driftwood, leading to collapse of the heap. It is very important to take measures to prevent such accidents.

Recently, the *Standard Construction Guidelines for Mining Waste Rock Heaps (Construction Guidelines)* have been implemented, and the *Guidelines for Site Selection, Dam Construction and Drainage* have been amended in accordance with the conclusions of very thorough research.

Since the proper implementation of these

guidelines, no accident due to inappropriate design of mine waste heaps has been reported in Japan. That is, there have been no accidents due to shaved dam surface, rise of seepage water or insufficient drainage capacity.

Damage to the underground tunnel

The design and manageability of the underground tunnel must be given thorough and deep consideration. Once the waste has been dumped, the underground tunnel can be impossible to maintain and may have structural problems. When this occurs, the tunnel is generally buried (filled with soil) and another tunnel built.

Piping in the dam

In addition to implementation of the guidelines for tailings dam construction and for improvement of technology and equipment, it is very important to control the level of hydration and permeation of water at the surface of a mining waste heap, in order to prevent accidents.

Failure or partial failure of the dam caused by earthquake

Failure caused by earthquake may result in a disaster. Adequate construction and management plans should therefore be implemented. Routine monitoring of the seepage water level is also a strict requirement.

However:

- ◆ A mining waste heap is different from a general water supply dam, as it only contains mining residues. It is relatively rare that piping occurs in a mining waste heap due to earthquake.
- ◆ Current construction guidelines include the requirement for the ability to withstand earthquake and there are standards for liquefaction. All the mining waste heaps in Japan were inspected fully after these guidelines were introduced.
- ◆ Examination of past accidents indicates that accidents due to earthquake are very few and that most cases are the result of exceptional accumulation of water in the mine site. A large-scale accident can be avoided if the level of hydration and permeation of water are properly controlled.

Design points for hazard prevention

Depending on the measures for prevention of mine hazards, the points explained below should be considered carefully during design stages.

Points for proper site selection, these are:

- ◆ Low inflows of soil and stone.
- ◆ Low possibility of collapse, landslide and avalanche.
- ◆ Solid ground and no groundwater or springs.

Drainage system

- ◆ In order to prevent driftwood and debris from blocking the drainage system, arresting equipment should be installed upstream of the site. Both horizontal and vertical screens are required at the entrance to the tunnel.
- ◆ Tunnel design is not only determined by the capacity to prevent inflow of water, but also by the requirements for good tunnel maintenance.

Table 2
Stabilization technology suggested by Construction Guidelines

Technology	Basics	Points for attention
1. Underground ditch, horizontal drainage hole	Blind ditch and drainage hole Drain through	Prevent piping and clogging
2. Gravel drainage	Set crushed stone in bubbling hole to lower water pressure during earthquake	Prevent piping and clogging
3. Sand drainage, paper drainage	Install vertical drainage system in the heap (sand or paper), then increase load	
4. Lime pile	Install vertical lime piles to increase the density of wastes	
5. Injecting cement and reagent	Solidify the wastes by injecting cement and reagent	Maybe fail when pH of seeping water is low
6. Adding soil	The density of the wastes may increase by being compacted by adding soil	It is necessary to remove the excess soil layer after the density of wastes becomes unsatisfactory
7. Vibroflotation	Put sand into the wastes and form a compound foundation by vibration	8 m deep maximum construction
8. Plate and pile	Put steel plate and pile or concrete pile into the wastes to increase the strength of the heap	When the seeping water is of low pH value, corrosion may occur
9. Soil compaction	Add soil at the front of the heap, or on the slope layer by layer to resist slide by the weight of the soil	
10. Cut slope	Form a gentle slope by cut	The cut soil should form a gentle slope and should not wash out in the event of a storm

Mining

ment, if forthcoming, leaves many vulnerable groups excluded from its benefits. Today, the promise of "development" is no longer enough to ensure that corporations and governments gain access to resources. The issue in some cases is precisely: "development" according to whose definition of quality of life and well-being? For whom? What kind of development?⁴

In this era of multi-culturalism, and environmental and human rights concerns, the mining industry is at a cross-roads. Access to information and communication technologies has allowed unprecedented visibility of the actual historical experience of many local communities with mining and with its lasting (positive and negative) effects on livelihoods and health, as well as of the non-mining options left to mining regions and communities once the minerals have been extracted. For some stakeholders the contribution of mining to sustainable and equitable development is far from clear. This perception is based on past and present cases of insufficient transparency in the management of information on the social and environmental impacts of mining, unequal distribution of its economic benefits between the federal and the municipal governments in some nations, and inadequate management of royalties and taxes. If trust and respect are accepted as the necessary ethical bases for equity and meaningful participation in decision-making processes, improving the quality, timeliness, accuracy, cultural compatibility and integrity of communication between stakeholders is a very real challenge. This in itself calls for a greater effort on the part of governments and companies to articulate inter-cultural protocols for the management of consul-

tation and negotiation processes for large-scale resource development projects.

To this end, another important challenge is establishing a "dialogue of knowledges", between mainstream science and practical traditional knowledge about the local environment. EIAs and SIAs, and the scientists in charge of predicting impacts, must incorporate methodologies that facilitate joint decision-making processes with local organizations in order to jointly evaluate impacts and plan for mine closure and rehabilitation from the outset. This would allow for the development of a better understanding of the restrictions and potential that a local ecosystem and social context imply for a projected mineral development, and thus provide the opportunity to design the project accordingly and put in place the necessary management systems. On the basis of this increased understanding, the challenge is to put in place multi-stakeholder monitoring systems that generate and maintain trust among stakeholders, a key cornerstone of lasting partnerships. Only through addressing these challenges will it be possible to develop forms of partnership with local communities that will respect their view of the purposes of development. Mining may then be seen to contribute towards increased levels of well-being in multi-cultural regions and localities.

Notes

- ¹ Ethnic integrity: "The maintenance of factors that are essential for the life, sustenance and recreation of the ethnic, economic, political, social, spiritual and cultural systems of indigenous peoples" (Direccion General de Asuntos Indigenas – Ministerio del Interior, Colombia, 1998. *Los*

Pueblos Indigenas en el Pais y en América: Elementos de política colombiana e internacional. Serie Retos de la Nacion Diversa, No. 1. Santafé de Bogotá).

² Parakh Hoon, Naresh Singh and Samir S. Wamali. 1997. Sustainable Livelihoods: Concepts, Principles and Approaches to Indicator Development. A Draft Discussion Paper. Prepared for the workshop on Sustainable Livelihoods Indicators. UNDP, New York.

³ Although demographic data on indigenous populations in many countries is often incomplete, it is estimated that there are some 300 million individuals who identify themselves as belonging to indigenous peoples in the world today. They inhabit 70 countries and are characterized by an enormous cultural diversity (COICA – Coordinadora de Organizaciones Indigenas de la Cuenca del Amazonas – In: Banco Mundial and OLADE, Tercera Reunion del Grupo Energia, Poblacion y Ambiente. Cartagena, 1999. *Consideraciones sociales y ambientales de las actividades hidrocarburíferas en áreas sensibles de la cuenca Sub-Andina*).

⁴ For an extensive critique of the "development" paradigm see: Arturo Escobar. 1995. *Encountering Development: The Making and Unmaking of the Third World*. Princeton University Press. Princeton. For discussion of development, post-modernism and multi-culturalism see also: Arturo Escobar. 1999. *El Final del Salvaje: Naturaleza, Cultura y Política en la Antropología Contemporánea*. Instituto Colombiano de Antropología & CEREC. Santafé de Bogotá.

Mining and World Heritage considerations

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A recent workshop on "World Heritage and Mining", organized by the World Conservation Union (IUCN), and the International Council on Metals and the Environment (ICME) in collaboration with UNESCO's World Heritage Centre in Gland (Switzerland) from 21 to 23 September 2000, explored this difficult relationship. The 1972 World Heritage Convention, one of the flagship legal instruments in the conservation field, protects sites of outstanding uni-

versal value. 630 of these are protected around the world in 118 countries. 430 cultural, 128 natural and 22 sites of both cultural and natural values are inscribed on the prestigious World Heritage List. Although the sites are nominated by the States Parties to the Convention (currently 161), these sites are the shared concern of humanity as a whole.

The responsibilities and obligations, as well as the benefits of the World Heritage Convention are

indeed enormous. The specific cases we have been dealing with, which are illustrated in Table 1, are far from being a matter of importance only to the particular sites in the countries, but are an issue of global concern. The World Heritage status of these sites makes their protection not only a responsibility of each of the States Parties but also for the international community as a whole. Mining and related issues concerning the management and protection of World Heritage sites are challenging the future implementation of the World Heritage Convention.

The necessity for a new dialogue with the mining industry can easily be demonstrated: disasters, such as the toxic mining spill threatening Donaña National Park (Spain) in April 1998, which led to such immense cleaning operations that the mining company became bankrupt, or the recent spill at Baia Mare, Romania which affected several World Heritage sites in the region including the Danube Delta (Romania) and Hortobagy National Park (Hungary), illustrate such a need. Increasingly, the World Heritage Centre, as Sec-

Tailings dams

In order to reduce seepage water levels and prevent dam failure due to earthquake and liquefaction, tailings dams should be designed to include two features:

- ◆ a drainage layer in the lower part of the dam;
- ◆ a water-proof layer and drainage layer on the inside slope of the dam.

Management of mining waste heaps for the prevention of mine hazards

Management activities for mining waste heaps should include some additional points:

- ◆ Keep good records of all the conditions of the drainage facility during the construction process, for the purposes of maintenance after construction.
- ◆ Keep complete records of all important measures in the case of emergency.
- ◆ Establish a system of checks for the tailings dam and drainage system, to be carried out in case of emergency such as leakage of water.
- ◆ Establish a checking system for use in cases of storm, continuous rain or earthquake.

Measuring equipment

Depending on the amount, degree of importance and type of tailings, the *Construction Guidelines* require the installation of measuring equipment for heavy rain, interval water pressure, hydration level and permeation of water. Hydration level and permeation are relatively easy to measure, it is therefore required that they be measured regularly (frequently).

Frequency of measurement

Frequency of measurement is indicated in Table 1.

Emergency checks and hazard prevention

Heavy rain and continuous rain

As bad weather can be forecast fairly accurately, the following six items should be checked carefully before a storm and emergency equipment should be readied.

- (1) Condition of roads under management.
- (2) Condition of hills upstream of the site (con-

cerns are deforestation, collapse, etc.).

(3) Condition of driftwood screens and drainage systems.

(4) Conditions on sites where the drainage facilities are located.

(5) Possibility of shaved surface, fissures, and sinking of soil.

(6) Condition of the wastewater treatment plant.

Measures for thaw

Before a snow storm or freeze, all six check-list items on the heavy-rain and continuous-rain check list should be considered.

Measures for earthquakes

Since it is difficult to predict an earthquake, the following six items should be carefully checked after an earthquake. If some of the systems have emergency status, emergency measures should be taken in preparation for aftershocks and rain:

- (1) Condition of the tailings dam (fissures, sinking of soil, collapse, etc.).
- (2) Condition related to water permeation (turbidity, volume, etc.).
- (3) Condition of the drainage facility (blockage, leakage, damage to building, etc.).
- (4) Condition of the waste water treatment plant.
- (5) Condition of roads under management.
- (6) Condition of hills upstream of the site (deforestation, collapse, etc.).

The technology for stabilizing tailings dams

Stabilization technology as regulated by the Construction Guidelines

The *Construction Guidelines* require lowering of seepage water levels in order to compact mining waste and to reinforce the tailings dam when dam safety cannot be ensured when the heap is in operation or closed. Table 2 shows stabilization technologies included in the *Construction Guidelines*.

Case study on stabilization of mining waste heap: the Oshidorisawa mining waste heap

The Oshidorisawa Mining heap is about 50 metres high. It is expected to accumulate an addi-

tional 14 metres before its closure.

With the *paper drainage* methods from the *Construction Guideline* continuing to be applied, sinking of the soil over 15 years will be about 8 metres, instead of 3 metres without these methods. This implies that the accumulation capacity of the heap will be increased by 5 metres by this method, and the strength of the soil will increase.

Whether a mine is active or closed, wastewater flows out from its dam. Such water generally contains large amounts of heavy metals and must be treated in accordance with the *Discharge Standards*. Although various water treatment methods may be used, neutralization is always applied.

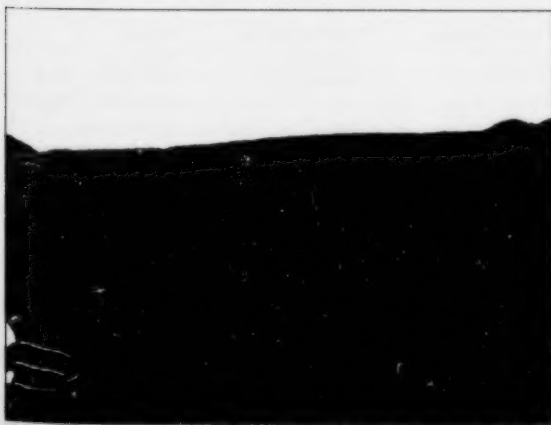
In order to reduce the accumulation of sediments resulting from neutralization and to improve the stability of the heap, the High Density Sludge (HDS) method is applied in some mines in Japan (e.g. in the *Yatani* and *Iwami* mines.) This method may prolong a site's service life and can contribute to lower utility costs for the heap.

The *Construction Guidelines* define vegetation as the condition that: "soil in the heap and that in the outside will be assimilated; the level of the seepage water should be lowered not to be harmful for the stability of the heap; and the wastes should be dehydrated adequately and solid, and it will be the same condition with soils outside of the heap."

From the point of view of hazard prevention, vegetation not only provides a good landscape but also reduces the heap management workload. Healthy vegetation should be an objective from the earliest stages of design, construction and operation.

For construction at inactive mines, three additional points should be considered in addition to vegetation:

- ◆ in order to keep the dam stable, the drainage facility should be installed within the site, to reduce residence time of the rain water and to lower the seepage water level in the dam;
- ◆ a driftwood screen should be installed to keep the off-site drainage facility operating normally;
- ◆ the underground tunnel should continue to be accessible to allow for maintenance, or the tunnel should be closed and a new tunnel built.



Rehabilitated tailings dam: Captical Steel Mine Corporation, China



Iron ore mine: Captical Steel Mine Corporation, China

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Selection of World Heritage Sites (potentially) threatened by mining

Natural sites

World Heritage Site	State party	Year of inscription	(Potential) threats to site	Mention of (potential) mining threats in nomination file	Mention of (potential) mining threats in IUCN and/or ICOMOS evaluation WCMC data sheet	Site on bureau and committee agenda, total figures	Listed on World Heritage in danger
Great Barrier Reef	Australia	1981	Mining, oil	Yes	Yes	15	No
Shark Bay	Australia	1991	Sand, gypsum, salt	Yes	Yes	11	No
Okapi Wildlife Reserve	Congo	1996	Illegal gold mining	Yes	Yes	9	(Yes, 1997)
Mt. Nimba Strict Nature Reserve	Guinea	1981-82	Iron ore	Yes	Yes	37	Yes, 1992
Lorenz National Park	Indonesia	1999	Oil, copper	Yes	Yes	2	No
Whale Sanctuary of El Vizcaino	Mexico	1993	Salt	No	Yes	16	No
Huascarán National Park	Peru	1985	Copper, zinc	No	Yes	14	No
The Virgin Komi Forests	Russia	1995	Oil, gas	No	Yes	2	No
Volcanoes of Kamchatka	Russia	1996	Gold	Yes	Yes	7	No
Doñana National Park	Spain	1994	Mining accident	No	No	8	No
St. Kilda	UK	1986	Oil	No	Yes	6	No
Yellowstone	USA	1978	Oil, gas	No	No	17	Yes, 1995
Greater St. Lucia Wetland Park	South Africa	1999	Sand	Yes	Yes	2	No

Mixed and Cultural Sites

Kakadu National Park	Australia	1981-87-92	Uranium	Yes	Yes	20	No
City of Potosí	Bolivia	1987	Silver	No	No	6	No
Hortobágy National Park	Hungary	1999	Mining accident	No	No	4	No

retariat of the Convention is faced with questions concerning mining operations next to World Heritage sites, such as coal mining in Jasper National Park in the Rocky Mountains Parks (Canada), zinc mining by Antamina near Huascarán National Park (Peru), or one of the large copper mining operations by Freeport next to Lorenz National Park (Indonesia). The case of Kakadu National Park (Australia), a World Heritage site inscribed for both its natural features and cultural values including aboriginal rock arts sites, made the headlines of newspapers around the World. The necessity felt by the World Heritage Committee was to hold an extraordinary session in July 1999, devoted exclusively to examining the case of Kakadu National Park (Australia), shows the increasing complexity of mining issues that the statutory organs of the Convention, the World Heritage Committee and its the Bureau as well as the States Parties of the Convention are called upon to review.

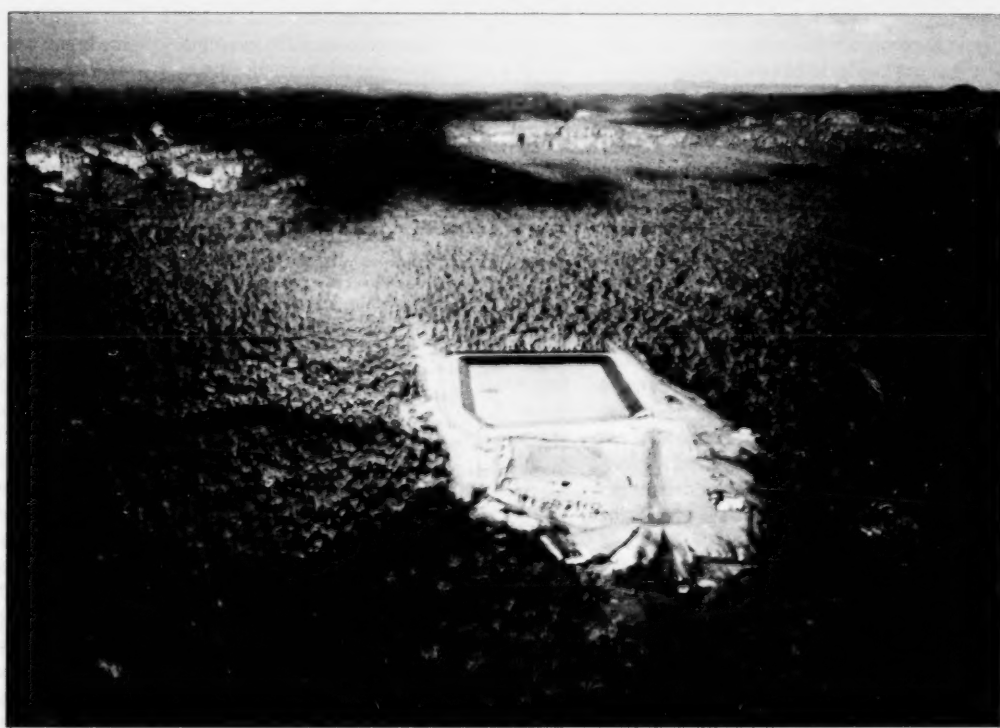
The presidential stop of the largest salt extraction projects on earth, in the Whales sanctuary of El Vizcaino (Mexico), was not only due to public interest and pressure by environmental groups, but mainly to the consideration given to protection of the integrity and the beauty of the World Heritage site for future generations.

The tasks facing us are indeed

enormous. Each case has to be considered on its own, each site is unique and the Convention text and the listing criteria, as presented in the Operational Guidelines for the Implementation of the Convention, have to be considered. However, questions of human and economic development also have to be taken into account. This one of the reasons why the Gland meeting also attracted the interest of other UN agencies, not only of UNEP

but also of UN/DESA and international institutes.

The best results in the new dialogue with the mining industry were achieved from reviewing specific case studies. During the past two years, the UNESCO World Heritage Centre and IUCN have been involved in the solving of specific problems to maintain the integrity of the Huascarán National Park. A working group has been created with representatives of the mining company, the



Status of construction of the Jabiruka uranium mine, October 1998, photo taken by UNESCO's mission

Designer waste

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Abstract

The usual current industry practice of placing tailings as slurry in a structure located close to the operating plant often results in excessive water and reagent consumption and an unnecessary exposure to chronic and acute risks. These risks can be offset to a large degree by designing the tailings disposal system to remove all excess water from the structure.

Résumé

La pratique actuelle qui consiste à stocker les résidus sous forme de boue dans une structure située à proximité de l'usine d'exploitation entraîne une consommation excessive d'eau et de réactifs, ainsi qu'une exposition inutile à des risques chroniques et graves. Ces risques peuvent, dans une large mesure, être réduits en concevant le système d'élimination des résidus de façon à éliminer de la structure tout excédent d'eau.

Resumen

Actualmente la industria tiende a utilizar desechos mineros como lechada en estructuras ubicadas cerca de la plantas de operación, lo que suele provocar el consumo excesivo de agua y reactivo y una exposición innecesaria a riesgos crónicos y graves. Estos riesgos pueden evitarse en gran medida diseñando el sistema de eliminación de desechos de manera tal de eliminar toda el agua excedente de la estructura.

The management of waste in the mining industry has historically been very low on the list of priorities of mining companies and governments. This attitude was very well expressed by the Tribunal appointed to inquire into the disaster at Aberfan in their report issued in July 1967, some eight months after that disaster. The three man Tribunal, chaired by Sir Herbert Edmund Davies, stated:

"At the start of this Inquiry we were aware of the fact that the great bulk of mining operations take place below ground and that most of the best men in the industry are employed there. It is there that the coal is won and in that direction that the attention of those employed in the industry is naturally turned. Rubbish tips are a necessary and inevitable adjunct to a coal mine, even as a dustbin is to a house, but it is plain that miners devote certainly no more attention to rubbish tips than householders do to dust bins."

Later in the same report the Tribunal issued a very strong statement about the way we in the mining industry go about our tasks. The Report states:

"As we shall hereafter seek to make clear, our strong and unanimous view is that the Aberfan disaster could and should have been prevented.....But the Report which follows tells not of wickedness but of ignorance, ineptitude and a failure in communication. Ignorance on the part of those charged at all levels with the siting, control and daily management of tips; bungling ineptitude on the part of those who had the duty of supervising and directing them; and failure on the part of those having knowledge of the factors which affect tip safety to communicate that knowledge and see that it was applied."

The management of tailings in most of the

mining industry has not, and is not being conducted with the overall design objective of ending up with a safe, stable and aesthetically acceptable post-operational tailings structure. One challenge that all of us involved in tailings management face is to advance our knowledge, assist others advance theirs and lead a thrust towards more stable and safer tailings structures. A second challenge will be to drive this change using cost effective solutions.

Since the Tribunal report in 1967, many good things have happened in our industry, but as tailings incidents over the past few years show our industry's record in "looking after its dust bins" has not improved as well as would have been expected. Acute tailings incidents are still occur-

ring, as shown in Table 1. The "rubbish" end of our business still has far too many bins being spilt over our neighbour's front gardens!

Table 1 shows that a major challenge is to get our industry to adopt the mindset that sorts wastes and maximizes their re-cycling (particularly of reagents and water), with the balance being disposed of in a safe, stable and aesthetically acceptable structure.

The general practice in the industry has been to receive wastes from the processing plant as slurry and place it in an impoundment, usually as close as possible to the processing plant. Many different impoundment structures have been developed to meet the combined challenges of the selected site and available resources (cash). All have a common design feature: they have to accept and handle the tailings slurry produced by the process plant. The tailings slurry, in turn, has its properties determined by the requirements of the metallurgical processing plant and the need to dispose of the tailings at the minimum direct operating cost. Very little real consideration is normally given to placing the tailings in a structure and in a condition that will optimize its short- and long-term safety, ultimate stability and aesthetic acceptability.

This means that post-mining decommissioning can be very expensive if the resulting structure is to be stable, safe and acceptable to the community. For example, many structures today are built using the upstream method although it is well recognized within the industry that this construction method produces a structure that is highly susceptible to erosion. In a recent paper Blight and Amponsah-Da Costa reported erosion losses of over 500 tonnes per hectare per year as being quite common on unprotected tailings slopes, with up to 200 tonnes per hectare per year being lost from vegetated tailings slopes. Structures with these erosion characteristics are unlikely to be defined as stable or meet the acceptance of the community.

I believe that it is necessary for the industry to reorientate its thinking with regard to waste management, particularly tailings, and to begin to make real efforts to design waste streams and

Table 1
Recent tailings related incidents, compiled by WISE Uranium Project,
10 March 2000

Date	Location	Parent Company	Type of Incident	Release
10 Mar 2000	Borsa, Romania	Remin S.A.	Tailings dam failure after heavy rain	22,000 t of heavy-metal contaminated tailings
30 Jan 2000	Baia Mare, Romania	Esmeralda Exploration 50%,Remin S.A. 44.8%	Tailings dam crest failure caused by heavy rain & snow melt	100,000 m ³ of cyanide contaminated liquid
26 Apr 1999	Placer, Surigao del Norte, Philippines	Manila Mining Corp	Tailings spill from damaged concrete pipe	700,000 t of cyanide tailings
31 Dec 1998	Huelva, Spain	Fertiberia	Dam failure during storm	50,000m ³ of acidic and toxic water
25 Apr 1998	Los Frailes, Spain	Boliden Ltd.	Dam failure	4.5 million m ³ of water and slurry
22 Oct 1997	Pinto Valley, Arizona, USA	BHP Copper	Tailings dam slope failure	230,000 m ³ of tailings and mine rock
29 Aug 1996	El Porco, Bolivia	Cormusur (62%), Rio Tinto(33%)	Dam failure	400,000 t

structures that are specifically directed towards nominated post mining land uses and effectiveness of post mining closure. In other words the final land use of the structure becomes as important a design objective as the decant system. This probably requires the tailings stream itself to become an integral and potentially variable part of design considerations. In effect the final structure must become a customer of the metallurgical plant rather than a receiver of the rejects from it. The waste should be designed and not just happen, otherwise our industry will not attain the level of community acceptance we require.

Why do we need to change? What are the problems associated with current tailings systems that we would like to eliminate through designing our waste? Table 1 listed a number of international examples of acute reasons why change is needed, but what of Australia?

The current tailings management practice in Australia has four commonly identified chronic difficulties:

- ◆ many structures suffer problems with seepage
- ◆ many structures carry supernatant ponds with potentially toxic concentrations of chemicals
- ◆ post operations rehabilitation often cannot be undertaken for many years after tailings deposition has ceased
- ◆ some structures are sources of considerable dust pollution.

Australia has not recently had the sort of acute tailings mishap that would be registered on the Table 1 data base, but should such an event occur the media and public focus on tailings management in the industry would increase considerably. This would raise the urgency with which we would need to address the chronic difficulties listed above, as well as the acute case that brought us to the public attention.

The elimination of these four chronic difficulties would go a considerable way towards making our industry's waste management acceptable to the community. The challenge is to design our tailings management so that:

- ◆ seepage is (practically) eliminated
- ◆ toxic chemicals are not retained in solution on the structure
- ◆ rehabilitation can be undertaken immediately after cessation of deposition
- ◆ the structure is stable against erosion.

The first three of the above design goals can be effectively met by managing the tailings as a paste or, slightly less effectively, as thickened tailings. None of these three design goals can be met using the slurry without thickening. The fourth design requirement can be addressed through either the current armouring of the structure wall using run-of-mine waste, or adding reagents (e.g. cement) to the paste in strategic locations.

Every mine is unique and not every operation would expect to arrive at the same tailings management solution. The decisions are rarely clear cut and the weighting placed by individual operators on various "properties" offered by different tailings management solutions will depend on their individual circumstances. Listed below is an attempt to compare the various "properties" of the three

Table 2
Comparison of properties

Properties	Slurry	Thickened	Paste
Final density	Low	Medium/high	High
Segregation	High	Slight	None
Supernatant water	High	Some	None
Post placement shrinkage	High	Some	Insignificant
Seepage	High	Some	Insignificant
Rehabilitation	Delayed	Immediate	Immediate
Permeability	Medium/low	Low	Very low
Application	Above ground	Above ground	Above and under ground
Footprint	Medium	High	Low
Water consumption	High	Medium	Low
Reagent recovery	Low	Medium	High

main tailings management options subjectively.

In Table 2 the term "paste" means a non-segregating material that has no supernatant water, "thickened" means tailings that have been thickened to reduce the amount of process water being discharged to the tailings structure, and "slurry" means tailings ex treatment process.

Will the image of our industry change if we are able to change our way of managing tailings and design for minimum chronic and acute risk?

One way of addressing this very important question is to consider some of the consequences of the seven recent tailings mishaps listed in Table 1. Esmeralda is currently in administration, probably on the road to bankruptcy; Romania and its neighbouring countries are in dispute; Boliden has a multi million dollar clean up bill; BHP Copper has been subject to legal action in the USA; all companies have suffered loss of production during clean up and intangible impact on employees and company image. If the operators of the projects listed in Table 1 had been able to predict the acute problems they have had I am certain they would have changed some of the design factors that contributed to their mishaps.

How many of the mishaps would have occurred and what would their overall impact have been if the tailings had been placed either as paste or thickened tailings rather than as slurry? In most of the mishaps the major problem reported was the supernatant water and the chemicals it contained, rather than the (solid) tailings in the structures. Operating with minimal or no supernatant water would, in most of the cases, have prevented the mishap from occurring. In other cases the overall impact would have been considerably less if there had been no supernatant water to distribute the solid tailings.

Overtopping and wall failure are both dramatic events that catch the attention of the world media. They can be avoided to a very large degree through the adoption of disposal systems that effectively eliminate excess water in and on the tailings disposal structure.

Table 2 compared the properties of the three general types of tailings with regard to the chronic challenges of seepage and rehabilitation, while

the potential utilization of the mine site post mining depends on post-placement settlement, the footprint, location and general stability of the structure.

At the extreme end of minimization of the impact of tailings disposal at a mine site, paste can be placed underground where it will have the added benefit of minimizing the chance of collapse of underground voids, itself a potential public safety issue. A less radical option for tailings management is to place tailings in an abandoned open pit, a solution that has been tried with various degrees of success at a number of operations in Australia. Using thickened tailings or paste rather than slurry avoids a major difficulty with in-pit disposal, namely the very long lead time between placement and the completion of settlement, and hence post-mining rehabilitation.

Increasingly in the mining industry decisions are being made on the basis of risk assessment. The seven recent examples of tailings mishaps in Table 1 and their consequences suggest that there is need for the industry to bring its risk assessment models up to date and to give due consideration to the real risks posed by failure to manage its tailings correctly. The usual current industry practice of placing tailings as slurry in a structure located close to the operating plant often results in excessive water and reagent consumption and an unnecessary exposure to chronic and acute risks. These risks can be offset to a large degree by designing the tailings disposal system to remove all excess water from the structure.

It is my view that this means seriously considering thickened tailings and paste as risk reducing options for tailings disposal.

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Environnement minier : résidus de l'industrie minière et alternatives de valorisation

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Résumé

Le traitement ou retraitement des résidus miniers est une des options possibles pour résoudre les problèmes de pollution liés à l'exploitation des mines. Le retraitement qui implique le plus souvent une reprise des résidus vise à séparer des minéraux à valeur marchande ou, au contraire, les minéraux possédant le plus grand pouvoir polluant (en particulier par la génération de solutions acides chargées en métaux lourds). Il ne doit pas se limiter au cas où son coût est entièrement couvert par les recettes de commercialisation des produits extraits. En effet un tel retraitement peut aussi diminuer le coût global de mise en sécurité des résidus miniers et de protection des populations, souvent très élevé pour des régions dont le passé minier est riche. Tout moyen de réduire ce coût ou d'apporter une recette participant à son financement sera donc bienvenue. En définitive, il apparaît du ressort des autorités administratives de considérer le problème d'environnement minier dans sa globalité et de favoriser les solutions qui permettent la banalisation des résidus débarrassés de leurs éléments polluants et la mise à profit des recettes possibles.

Abstract

Waste reprocessing is one way to solve pollution problems related to mining. The purpose of reprocessing, which generally begins with waste collection, is to separate out valuable minerals from highly polluting ones (especially those which generate acid solutions containing concentrations of heavy metals). Reprocessing should not be limited to instances in which it is directly paid for through sales of reprocessed materials. It can also reduce the overall costs of confining wastes and protecting the potentially affected public. These costs are often very high in regions where there has been a significant amount of mining in the past. Any means of reducing the costs of safety measures, or helping pay for them, would therefore be welcome. Public authorities should consider the environmental problems of the industry in their entirety and support solutions that permit the removal of pollutants from mining wastes and the sale of as much of the remainder as possible for profit.

Resumen

El reciclado o la reutilización de los residuos mineros podría ser la solución adecuada para el problema de la contaminación causada por la explotación minera. La reutilización, que en la mayoría de los casos implica la recogida de los residuos, sirve para separar el mineral con valor comercial del que contiene más agentes contaminantes (susceptibles de generar soluciones ácidas, ricas en metales pesados). Esta selección no debe limitarse a los casos en que la comercialización de los productos extraídos cubran todos los costes del tratamiento. De hecho, este tipo de práctica reduce considerablemente el coste global de la seguridad en el tratamiento de residuos y de la protección de la población, que suele ser muy elevado en las regiones de importante tradición minera. Lo que se procura por todos los medios es reducir este coste, o lograr posibles fuentes de financiación. En definitiva, corresponde a las autoridades administrativas hacerse cargo de este problema medioambiental y encontrar la solución adecuada para minimizar los residuos, previa eliminación de los agentes contaminantes, de la forma más económica posible.

Introduction

Le domaine de l'environnement minier est très vaste puisqu'il englobe les précautions à prendre dès la phase de la prospection géologique jusqu'aux solutions à apporter au traitement des points noirs résultants d'activités industrielles passées qui ont souvent un impact négatif important au niveau régional (en particulier sur la qualité des eaux utilisées pour l'alimentation humaine). Aujourd'hui,

les préoccupations environnementales sont prises en compte durant toutes les phases de l'exploitation. Un aspect commun à ces différentes problématiques est l'importance des interactions, en surface ou en profondeur, entre l'eau et les roches (figure 1), à partir des micro phénomènes à l'origine des sources de pollution après perturbation des circulations et des équilibres eau-roches-atmosphère jusqu'aux effets sur la santé des populations

humaines qui, la plupart du temps, proviennent d'une dégradation de la qualité des eaux d'alimentation.

Les quantités de ces résidus qui créent des nuisances sont considérables, aussi bien dans l'absolu que par rapport à la quantité des produits de valeur extraits du sol, en particulier quand les minerais extraits sont à très faible teneur, comme dans le cas de minerais d'or ou de diamant. Pour l'or par exemple, si l'on considère qu'annuellement 2300 tonnes sont produites à partir de minerais titrant en moyenne 5g/tonne et si l'on suppose que le rapport, au niveau de la mine, entre le stérile qu'il faut extraire pour avoir accès au minerai et le minerai lui-même, est de 1/1 (taux de découverte), le tonnage total de résidus accompagnant la production de ce tonnage d'or sera d'environ un milliard de tonnes.

Le problème actuel est aggravé par l'existence de résidus anciens générés par l'industrie minière passée qui trop souvent se préoccupait peu de ses déchets. Ainsi il existe au Canada 750 millions de tonnes de résidus miniers et 1,9 milliards de tonnes de résidus de traitement sulfurés dont la mise en sécurité par inertage coûterait entre 1 et 2 \$ par tonne, soit l'équivalent en valeur contenue de 0,1 à 0,2 g/t d'or.

En dehors de l'impact directement lié à l'extraction du minerai lui-même, les nuisances générées se situent à plusieurs niveaux. La pollution chimique des eaux superficielles et souterraines ainsi que la contamination des sols par des métaux lourds et des ions acides, voire radioactifs (drainage acide), sont probablement les plus importantes. Bien d'autres effets polluants doivent être mentionnés, même dans le cas où ces résidus sont inertes ou considérés comme tels (Bortnikova S. et Morizot G., 1997).

- ♦ immobilisation de surfaces cultivables ou utilisables à d'autres fins,
- ♦ destruction de l'écosystème local,
- ♦ effet sur l'organisation du réseau hydraulique (depuis la simple sédimentation de particules fines ou «siltation», dans le moindre des cas, jusqu'à la destruction complète du régime hydraulique dans d'autres cas),
- ♦ risques de glissements de terrain,
- ♦ destruction du paysage,
- ♦ pollution aérienne,
- ♦ ...

Il est difficile de ne pas faire de rapprochements entre l'existence de telles sources de pollutions et l'observation d'une espérance de vie abrégée d'une dizaine d'années pour les populations locales directement concernées par rapport aux populations vivant à quelques dizaines de kilomètres, voire quelques kilomètres dans des zones préservées de ces pollutions (Dzhida République Bouriate, CEI 1997 ; Kolonin et alii, 1994 – Subarnarekha Basin, Etat de Bihar, Inde).

L'objet du présent exposé n'est certes pas de présenter l'ensemble des problèmes environnementaux liés aux résidus miniers, mais de montrer comment la prise en compte des caractéristiques propres à ces résidus peut dans un certain nombre de cas contribuer à participer au coût de la mise en sécurité de ces résidus. Or celle-ci apparaît aujourd'hui indispensable dans le cadre du développement durable, non seulement pour la préservation immédiate des populations concernées, mais aussi pour l'acceptabilité de la poursuite de l'activité minière, indispensable au développement de l'humanité.

Résidus miniers et résidus de traitement

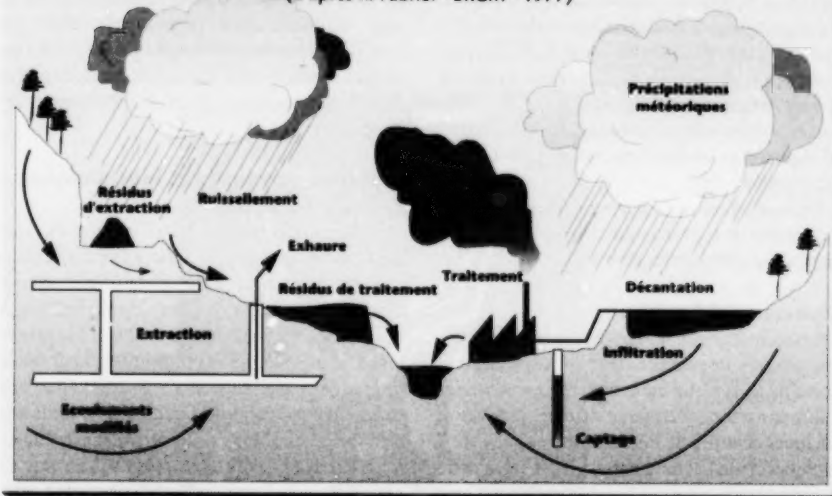
La plupart du temps on peut distinguer deux types de résidus miniers :

- les résidus miniers proprement dits sont les roches de teneur en éléments de valeur nulle ou infra économique (trop faible), extraites du sol seulement parce que leur extraction est indispensable pour accéder au minerai lui-même, compte tenu de la méthode minière choisie. Ces résidus se présentent le plus souvent sous forme de blocs rocheux, relativement peu réactifs chimiquement et de tenue mécanique normale ; parfois il peut s'agir de recouvrement argileux ou encore du sol arable superficiel ;

- les résidus de traitement sont obtenus à l'issue du processus d'extraction des éléments de valeur du minerai (opération de traitement). Ils se composent de particules relativement fines dont la taille des plus grosses est de quelques dizaines voire de quelques centaines de microns. Cette faible granulométrie résulte de l'opération de broyage des roches nécessaire aux différentes opérations d'extraction des minerais. La plupart des procédés de traitement se réalisant en milieu aqueux, ces résidus se présentent fréquemment sous forme de particules solides en suspension aqueuse. Ils sont alors souvent très réactifs du fait de cette finesse et de leur composition minéralogique, notamment quand la minéralisation de valeur économique est sulfurée. Leur tenue mécanique est fréquemment médiocre.

La principale distinction entre ces deux types de résidus est leur granulométrie. Il en découle des caractéristiques géotechniques et une réactivité physico-chimique très différente qui ont un impact important sur l'usage que l'on peut en faire. Ainsi, les résidus ayant subi le processus de broyage inclus dans un procédé de traitement, bénéficient déjà d'une certaine valeur ajoutée liée à leur finesse. Les éventuelles opérations de retraitement ou d'extraction des valeurs résiduelles seront moins énergivores. De même les éventuelles réutilisations comme par exemple en produit de charge en seront facilitées.

Figure 1
Schéma global des interaction eaux/roches dans un contexte minier
(d'après R. Fabriol - BRGM - 1977)



Différentes voies de valorisation des résidus de l'industrie minière

La valorisation des résidus de l'industrie minière peut se faire par différentes approches, soit en s'efforçant, comme s'il s'agissait d'un minerai, d'en extraire des produits marchands, soit en considérant le résidu comme un tout valorisable dans son ensemble, par exemple pour en faire une matière première de travaux publics ou pour créer un sol agronomique parfois moyennant l'ajout d'éléments fertilisants (Cadillon M., Lencar R., 1997). Une combinaison des deux approches est évidemment possible : elle permet d'extraire de leur gangue qui sera ensuite banalisée ou valorisée soit des minéraux directement marchands comme du charbon, soit des minéraux potentiellement polluants comme des sulfures susceptibles de nuire à la fois à l'utilisation en agriculture et en travaux publics par relargage d'acide et de métaux lourds. Cette approche bien développée en Europe occidentale, en particulier pour les résidus de l'industrie charbonnière (Delaume M., 1997) doit obligatoirement prendre en compte le développement socio-économique local et les besoins qui lui correspondent. Par exemple, la valorisation de matériaux pouvant servir de soubassement à des constructions d'autoroutes ou à des parcs de golf ou encore comme matière première industrielle (argiles, calcaires, etc.) ne sera pas la même dans une région où l'activité de génie civil est dense et l'extraction de granulats réglementée et dans une région à faible densité de population et de développement.

Les résidus miniers ont été produits par des procédés de traitement correspondant à l'état de l'art existant sur le site de production au moment de cette production. Or, les performances technico-économiques des procédés de traitement se sont améliorées avec le temps, ce qui leur a permis de satisfaire à des contraintes plus sévères comme l'appauvrissement des minerais traités (les minerais les plus riches s'épuisant), ou la baisse généralisée depuis plusieurs décennies des cours des matières premières (Lassonde P., 1997) : il apparaît donc

normal que des techniques récentes puissent de façon économique extraire une nouvelle quantité de minéral de valeur d'un stérile élaboré quelques dizaines d'années plus tôt. Parfois même il arrive que des résidus soient retraités à plusieurs reprises et à un intervalle de quelques années par des techniques identiques, mais aux performances si médiocres qu'à chaque fois ce n'est qu'une fraction modeste du métal de valeur, mais économiquement suffisante aux yeux de l'opérateur, qui est extraite : on explique parfois cette nouvelle récolte par « une régénération » avec le temps du minéral de valeur !

Procédés physiques et physico-chimiques

Procédés gravimétriques

L'introduction des séparations par milieux denses, basées sur une séparation dans une suspension à base de ferrosilicium ou de magnétite de densité intermédiaire entre les densités des deux minéraux à séparer ne sont certes pas très récentes car elles datent de plus d'une quarantaine d'années, mais elles ont permis d'extraire des quantités appréciables de charbon des résidus de traitement effectués avec des méthodes plus rustiques et elles gardent certainement un bon potentiel en Europe centrale et orientale ainsi qu'en CEI (le manque de disponibilité de pompe de qualité y interdisait leur emploi). Ces procédés (figure 2) s'appliquent à des particules de dimensions millimétriques ou centimétriques.

Les séparateurs centrifuges sont des équipements relativement nouveaux. Grâce au remplacement de la force de la pesanteur par une force centrifuge de plusieurs dizaines voire de plusieurs centaines de g, ils permettent la séparation de particules fines (quelques dizaines de μm), de poids spécifiques différents ; initialement développés pour le traitement des minerais d'or, ils s'adressent maintenant à de nombreux autres types de minerais et leur futur apparaît prometteur pour l'extraction des minéraux lourds contenus dans les résidus (figure 3).

Séparations magnétiques

Des progrès importants ont également été faits dans le domaine des séparateurs magnétiques, d'une part grâce à l'introduction d'aimants permanents à base d'oxydes de Terres Rares qui permettent une plus grande efficacité pour un prix de revient nettement plus bas, et d'autre part grâce au développement du cryomagnétisme mettant en application les développements récents de la supra conductivité.

Des utilisations sont à prévoir, par exemple dans le domaine de la production de minerais de fer à partir de résidus latéritiques.

Séparation par flottation

Les techniques de flottation ont également fait des progrès importants, notamment dans le domaine de la récupération de particules de granulométrie non classique (soit inférieure à quelques dizaines de microns, soit supérieure à quelques centaines de microns), ou dans celui de la séparation entre minéraux de propriétés physico-chimiques proches. Utilisée depuis longtemps pour le retraitement des résidus, par exemple pour extraire de la fluorine ou de la barytine à partir de résidus d'extraction du plomb ou du zinc, la séparation par flottation paraît être spécialement recommandée pour séparer les minéraux sulfurés contenus dans un résidu de traitement, soit avec l'objectif de tirer un profit direct de ces sulfures, soit avec celui de permettre la banalisation du résidu qui, privé de ses sulfures,

n'aura plus de réaction acide; les deux objectifs peuvent bien entendu être combinés. Une difficulté résidera ensuite dans la séparation des différents sulfures, leur permanence dans les conditions physico-chimiques existant dans les stériles rendant cette séparation beaucoup plus difficile que pour des sulfures fraîchement extraits de leur minerai.

Procédés chimiques et biochimiques

Procédés chimiques

Des procédés comme la lixiviation sulfurique sont depuis longtemps utilisés sur des résidus miniers, en particulier de cuivre ou d'uranium, dans des opérations appelées « dump leaching » qui s'effectuent par arrosage des blocs à la granulométrie de leur extraction minière. Leur faible teneur en métal de valeur ne justifie pas leur concassage et à condition que les blocs aient une certaine perméabilité, ce traitement peut être en lui-même économique, surtout s'il est mis en oeuvre pendant l'exploitation minière principale; l'infrastructure existante (et notamment le module de traitement des solutions) est alors pleinement utilisée et amortie sur une plus grosse production.

La cyanuration est elle-même largement pratiquée sur les résidus de l'industrie minière, qu'il s'agisse des résidus miniers ou des résidus de traitement (Baret G., 1996). Relativement peu utilisée dans le passé dans certains pays, notamment sous sa variante incluant une récupération de l'or par charbon actif, cette technique est probable-

ment celle qui a conduit aux plus nombreuses installations de retraitement de stériles de type purement commercial.

Procédés biologiques (ou procédés chimiques catalysés par action biologique)

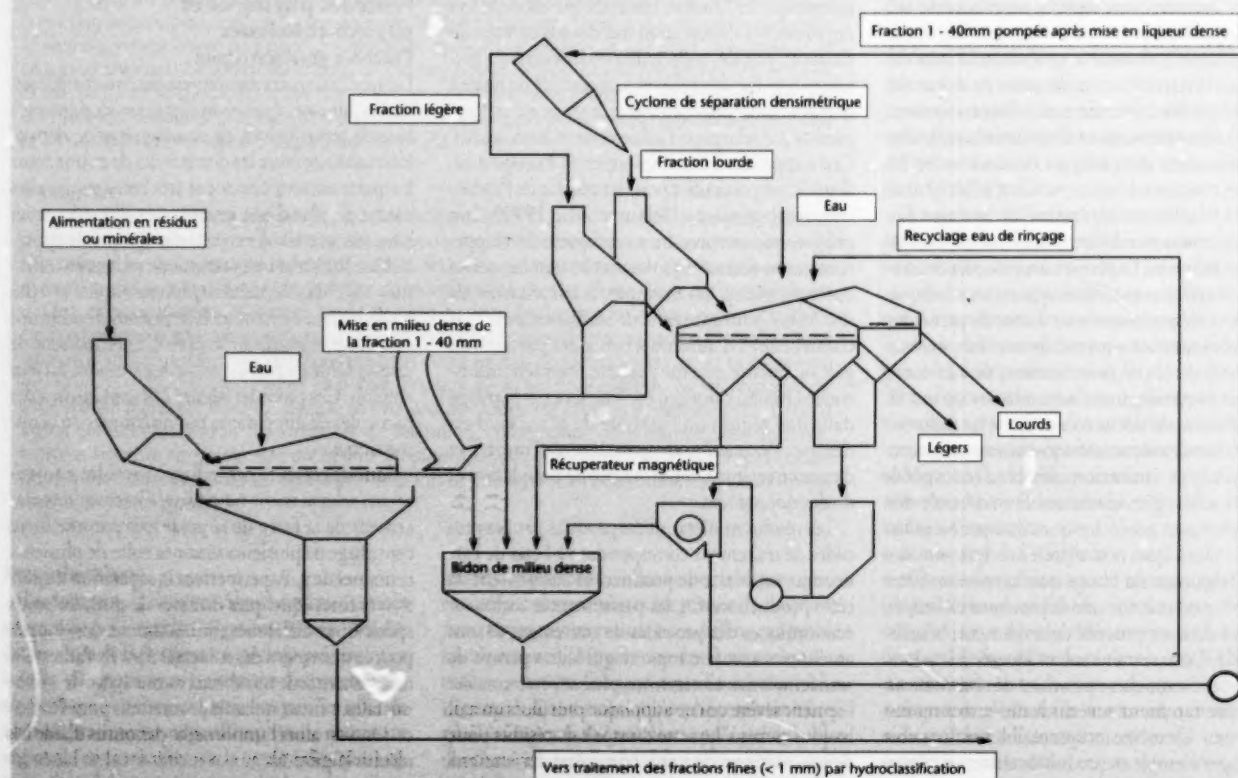
La percée récente des traitements de biolixiviation, en particulier pour catalyser l'oxydation des sulfures est présentée en encadré par D. Morin sous une application à des résidus de traitement. Elle est applicable à de nombreux types de sulfures et notamment à la chalcopirite grâce à l'utilisation de nouvelles souches bactériennes (thermophiles extrêmes). Elle permet d'envisager le cas souvent rencontré de mélanges de sulfures. Une difficulté économique subsiste: la séparation des différents métaux à partir de la solution quand celle-ci est complexe.

Approche à privilégier

Sur une base économique, il paraît nécessaire de distinguer les cas suivants:

- ◆ le coût de l'extraction des éléments de valeur est inférieur à la valeur commerciale de ces éléments;
 - ◆ le coût de l'extraction des éléments de valeur est supérieur à la valeur commerciale de ces éléments.
- Il s'y ajoute dans ce cas l'alternative suivante:
- ◆ le retraitement des résidus ne présente pas d'intérêt global;
 - ◆ le retraitement des résidus présente un intérêt global.

Figure 2
Schéma d'un procédé de séparation par milieux dense (d'après documentation Tercharmor)



Cas où le coût de l'extraction des éléments de valeur est inférieur à la valeur commerciale de ces éléments

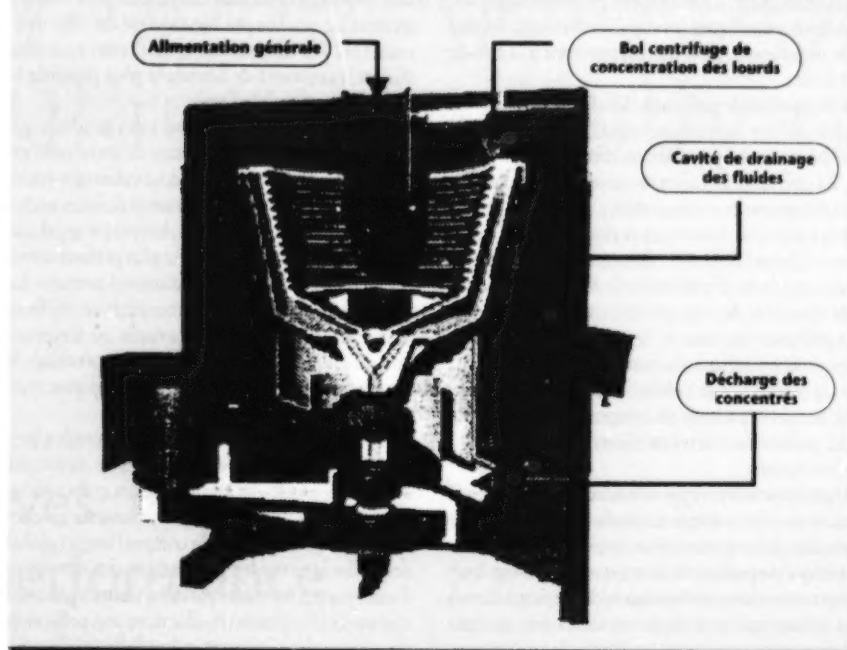
Ce cas, actuellement le plus connu et le plus facile à résoudre, peut être mis en oeuvre sur la base d'une initiative privée simple. De nombreux exemples peuvent être cités, notamment dans le domaine de l'or pour lequel bien souvent une opération de cyanuration, soit en cuve, soit en tas, permet, éventuellement après un rebroyage, de récupérer une quantité suffisante d'or à partir de résidus produits précédemment par une autre méthode (gravimétrie, flottation : exemple : Salles). La limite de rentabilité d'une opération d'extraction d'or pour des minerais frais se situant dans le meilleur des cas aux environs d'une teneur de l'ordre du g/tonne par cyanuration en tas ou de quelques centaines de mg/tonne par gravimétrie à partir de minerais alluvionnaires, on peut espérer extraire économiquement de l'or de résidus miniers pour des teneurs analogues. Malheureusement, le problème se complique souvent du fait des caractéristiques minéralogiques des résidus miniers : trop souvent -et en particulier quand l'impact de ces résidus sur l'environnement est majeur- l'or est accompagné d'une quantité telle de minéraux sulfurés eux-mêmes consommateurs de cyanure que le procédé de cyanuration devient prohibitif ou bien la forme de l'or est telle que son extraction par gravimétrie n'est pas économique ; cela se produit lorsque l'or extrêmement fin est lié à des sulfures ou encore finement associé à d'autres minéraux comme le quartz. De nombreux autres cas peuvent être cités, pour des métaux de base (Zinc de Zeldija au Maroc, Cu-Co de Kolwesi au Congo, Co de Bou Azzer au Maroc, Pb-Zn de Haute Silésie en Pologne), pour des métaux d'alliage (étain de Colquiri en Bolivie, tungstène), pour du charbon, etc.

Bien entendu, pour les autorités en charge il sera indispensable de concéder les permis d'exploitation correspondants, de s'assurer que la mise en sécurité des nouveaux résidus produits s'effectuera dans des conditions correspondant aux normes internationales et en particulier ne laissera pas subsister de désordre écologique : en effet, la teneur résiduelle des nouveaux stériles ne devrait pas permettre avant longtemps leur reprise et l'effacement de points noirs environnementaux dans des conditions d'autofinancement.

Cas où le coût de l'extraction des éléments de valeur est supérieur à la valeur commerciale de ces éléments

La reprise et le retraitement de ces résidus ne peuvent pas alors se justifier économiquement par la seule production associée de produits marchands, mais ils peuvent l'être si on prend en compte le problème d'une façon plus globale, en particulier en considérant le coût de la pollution et le coût des solutions alternatives permettant de faire cesser l'effet de cette pollution sur les populations concernées. L'initiative de ces opérations ne peut alors que rarement revenir à un entrepreneur privé, sauf si, cas exceptionnel, lui est possible de prendre en compte le problème dans sa globalité économique.

Figure 3
Vue en coupe d'un séparateur centrifuge (d'après documentation Knelson)



Il faut alors distinguer deux situations, en fonction des coûts globaux des deux approches :

Le retraitement des résidus ne présente pas d'intérêt économique global

Entrent dans cette catégorie les résidus ne produisant pas de pollution ou de gêne particulière ou bien pour lesquels des solutions peu onéreuses (en particulier n'impliquant pas une reprise du tas de résidus) peuvent limiter à des niveaux acceptables l'impact de la pollution (résidus mis en place sur des sols soit imperméables, soit jouant des rôles tampons vis-à-vis de la pollution chimique générée).

Bien entendu, le retraitement des résidus ne sera pas alors la solution à retenir, sauf si une préoccupation à long terme de développement durable inciterait à éliminer toutes les causes potentielles de pollution, fussent les moins probables.

Le retraitement des résidus présente un intérêt global

Ce cas se présente surtout lorsque, sur la base de l'intégration de tous les paramètres socio-économiques locaux, le coût de la suppression de l'effet de la pollution et des nuisances par une méthode mettant en oeuvre le retraitement des résidus est inférieur au coût de la suppression de cet effet par toute alternative acceptable, grâce aux recettes tirées de la valorisation de ce qui aura été extrait des résidus.

Dans certaines circonstances, il peut en effet être intéressant de séparer les différents constituants des résidus, et cela, pour des raisons variées :

- ♦ l'obtention des éléments nocifs sous une forme concentrée permet de limiter le coût d'un confinement sévère qui ne s'applique plus alors qu'à un volume limité. Le reste du stock de résidus pourra soit rester sur site, soit être utilisé, par exemple en travaux publics. En tout état de cause, il sera

plus facile de garantir un confinement strict s'il est limité à un volume faible que s'il s'adresse à un volume très important ;

- ♦ l'élimination d'une source de pollution liée, par exemple, à la présence de sulfures de métaux lourds générant des solutions acides peut permettre d'éviter tout aussi bien l'impact direct sur la santé de la population des eaux de rivière ou de nappes polluées dont elles s'abreuvent, ou des aliments concentrant la pollution qu'elles consomment, et le coûteux traitement chimique curatif de ces eaux (au Kazakhstan, par exemple) ;

- ♦ la libération de surfaces occupées par les tas de résidus au profit de leur mise à disposition pour des utilisations agricoles, industrielles ou sociales, de même que la suppression des effets polluants divers (sur l'écosystème, le réseau hydraulique, l'atmosphère, le paysage) correspondent à des gains significatifs pour les communautés locales et régionales, que l'on sait de mieux en mieux quantifier.

Dans ces différents cas, il apparaît clairement que la globalité sous laquelle l'économie du système doit être considérée est subordonnée à une supervision directe par l'Administration régionale qui devra veiller à ce que les solutions techniques retenues prennent bien en considération l'optimisation de l'ensemble des critères socio-économico-politiques : dans certains cas extrêmes, une solution techniquement simple de ces problèmes d'impact des pollutions liées à l'existence de stériles miniers pourrait être basée sur le déplacement des populations, solution qui n'est pas sans lourdes conséquences politiques et sociales.

On voit alors l'importance des outils d'aide à la décision destinés aux autorités locales, basés sur des approches faisant notamment appel à des sys-

tèmes géographiques d'information (SIG) prenant en compte à la fois des critères géologiques, géochimiques, hydrauliques, hydrogéologiques, socio-économiques (occupation des sols, densité de population, etc.) qui permettront à la fois de définir :

- ◆ la capacité de pollution des différentes sources identifiées et leur impact actuel et futur, direct et indirect, sur les populations concernées ;
- ◆ les différents scénarios de surveillance et d'action techniquement envisageables ;
- ◆ la hiérarchie des risques et des problèmes à traiter : Chevrel S. (1997) démontre l'intérêt d'une telle approche d'utilisation de SIG dans l'analyse de sensibilité de l'impact des activités minières sur la pollution des eaux et des sols sur un terrain de jeu situé en Afrique du Sud ;
- ◆ un plan d'action cohérent basé sur les données de terrain et prenant en compte, à la fois l'impact des pollutions et les contraintes économiques.

Conclusions

Dans les problèmes liés à l'environnement minier, la facette du traitement ou du retraitement des résidus qui constitue une partie importante des sources de pollution, correspond souvent à un enjeu économique important, d'une part à travers la récupération d'éléments de valeur qui ont échappés à une première phase de traitement, d'autre part à travers l'isolement de minéraux pol-

luants qui permettra une mise en sécurité plus aisée de la seule fraction polluante et également une banalisation du reste des résidus. Une mise en sécurité de résidus par inertage est en effet coûteuse (1-2 \$/tonne, comme nous l'avons vu ci-dessus) et il convient de limiter le plus possible le tonnage à isoler de la sorte.

Que ce traitement s'adresse à des produits qui ont déjà subi une première étape de traitement ou pas (cas des résidus miniers), leur valorisation sera basée sur une bonne connaissance de leurs caractéristiques minéralogiques et devra faire appel aux techniques minéralurgiques les plus performantes, car techniquement comme économiquement les objectifs seront ambitieux (récupération de fines particules, séparation de minéraux ou d'espèces dissoutes dilués et aux propriétés très proches). Il est certain que des progrès technologiques sont souhaitables dans ces domaines.

Par ailleurs il est important que les autorités administratives suivent de près ces actions de traitement ou de retraitement des résidus miniers et des résidus de traitement, d'une part pour s'assurer qu'elles seront menées en prenant en compte l'impact global des pollutions sur les populations concernées et d'autre part en favorisant par des mesures législatives appropriées l'utilisation des fractions non polluantes des résidus dans l'activité industrielle (génie civil, matériaux de construction, etc.).

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Voluntary non-regulatory and regulatory initiatives

Voluntary initiatives: improving environmental performance

Voluntary approaches and initiatives have been used increasingly by industry and governments as a policy tool alongside regulations to improve environmental performance. These initiatives have ranged from commitments by individual companies to achieve environmental targets to codes of conduct adopted unilaterally at the national or international level by sectoral industry associations, to agreements on environmental performance targets between a government and a company, group of companies or industry sector.

There are a number of advantages for industry in the use of voluntary approaches. These include greater flexibility concerning ways and means of reaching targets, the opportunity to present a better public image and an opportunity for industry leaders to differentiate themselves from others in their field often leading to competitive advantage.

For governments, the benefits of voluntary industry approaches include their usefulness in promoting dialogue with the private sector and in raising industry awareness of environmental issues. They can serve as tools to push industry's environmental performance and resource productivity beyond previously agreed regulatory targets. In addition, such voluntary activities can promote innovation and limit enforcement costs.

Non-governmental organizations also recognize that appropriate use of voluntary initiatives can be beneficial. However, they generally insist on the importance of establishing measurable targets, of involving employees and NGOs in setting and implementing these targets, of report-

ing on progress and, of third party verification.

UNEP's contribution to the debate was an analysis of voluntary actions already undertaken. This resulted in an understanding of the five critical aspects to make codes effective (commitment, content, collaboration, check and communicate). In 1998, UNEP produced "Voluntary Industry Codes of conduct for the Environment," guidelines for the purpose of providing guidance to industry associations, governments and others on how to develop and use voluntary codes. Providing real examples, the guidelines demonstrate what can be achieved identifying how voluntary codes can be used as a tool to contribute to sustainable development.

Voluntary code for the use of cyanide in mining

The gold industry has signalled its intention to develop a voluntary global Code for the management of cyanide in mining. UNEP, working with the International Council on Metals and the Environment, is supporting this initiative. The two organisations convened a multistakeholder workshop in Paris in May 2000. Discussion commenced at that workshop on issues relating to scope, coverage and content, and a process was agreed to oversee the work. A broad stakeholder Steering Committee was established and there is widespread consultation occurring within the gold industry. There is strong support for such a Code and it is expected to be implemented in early 2002.

The power of such a Code will be in the fact

that it has the potential to apply wherever companies operate and to attract signatories from companies of different scales. It would set out principles and practices in all key areas of cyanide handling, storage, usage and disposal, and would address risk reduction in the various phases of cyanide usage as well as emergency response. It will be responsive to the concerns of communities as well as drawing on sound science to reduce environmental and human risks which can arise from cyanide use. Implementation of the Code has the potential to reduce substantially the risks associated with cyanide use in gold mining.

ISO standards and mining

ISO 9000 and ISO 14000 are families of standards which are referred to under these generic titles for convenience. They consist of standards and guidelines relating to management systems, and related supporting standards on terminology and specific tools, such as auditing. ISO 9000 is primarily concerned with "quality management" meaning what the organization does to ensure that its products conform to the customer's requirements. ISO 14000 is primarily concerned with "environmental management" meaning what the organization does to minimize harmful effects on the environment caused by its activities. ISO 14000 addresses whether or not everything is being done to ensure a product will have the least harmful impact on the environment, either during production or disposal, either by pollution or by depleting natural resources. As an known mining example, the SAMA Mineracao de Amianto Ltda mine in Brazil received the 9002 ISO certification for its quality control processes and in 1998 qualified for 14001 environmental management certificate from Det Norske Veritas for all activities related to mining and processing of chrysotile.

The greenhouse challenge

Australian industry, working with the Australian Government, developed and implemented a program of voluntary reductions of greenhouse gases. The program, which has run over some 5 years has

attracted widespread membership and strong commitment from industry and has produced impressive reductions in greenhouse gas emissions in both absolute terms as well as relative to either business-as-usual, or emissions per unit of production.

Each member company develops an inventory of emissions and an action plan of projects to reduce emissions, which is updated yearly. The company submits its plan to government and reports to it on performance against plan. Companies participating have described the cultural and management change which has resulted from the program and the business benefits which have also accrued in many cases as increased focus has been placed on energy and other operational efficiencies. The mining and minerals processing sectors have been at the forefront of the program. In terms of participation in the Greenhouse Challenge Program by the Australian minerals industry, the

recent Evaluation Report highlights that 78 per cent of emissions from mining (including 91 per cent from coal mining) are covered by companies participating in the Greenhouse Challenge Program. On the minerals processing side, 89 per cent of emissions from machinery and metals manufacturing is covered by the Challenge with 100 per cent coverage from aluminium and iron and steel.

Orphan site clean-up

An innovative scheme started in the United States by The Conservation Fund and the National Geographic Society has resulted in Asarco Inc. (now part of Grupo Mexico) cleaning up an abandoned mine site that it does not own. The scheme encourages companies to adopt voluntarily an abandoned site for which they have no liability and to clean it up for a desired benefit or credit. In Asarco's case, a mine waste pile at the former Queen Elizabeth and

Tomboy mines in Clear Creek, near Idaho Springs, was remediated by removing the waste. The waste was disposed of in the Keensburg facility owned by Coors Brewing Co., free of charge. The project was coordinated by Colorado's Department of Public Health and Environment, the US Environmental Protection Agency and the Clear Creek Watershed Forum.

Accelerated reduction and/or elimination of toxics (ARET)

In 1991, toxic substances were a focus for the Canadian mining industry and, with academics, the environmental community approached the Canadian government and launched a process to identify and reduce or eliminate toxic substances linked to industrial activity. The subsequent ARET programme by 1993 targeted some 117 substances, in five categories, for reductions of 90% for 30 of the most bioaccumulative sub-

International Conventions and Guidelines Affecting Mining

A number of environmental issues have such extended scope – either in their impact or in the way they need to be addressed – that only a collective approach to action can be effective. Global issues such as climate change or biodiversity are two examples of issues of truly international importance. Where trade restrictions are used to mitigate environmental impacts, as for example in the transfrontier dumping of waste, again only international action can solve this problem.

International Conventions on Environment, sometimes called Multilateral Environmental Agreements or MEAs, have been developed by the international community of nations to address this global aspect of our environmental agenda. The increasing globalisation of our economic and social fabric has resulted in a large number of such global instruments on environment protection. Many of these are relevant to the mining industry, although few actually single out mining in the text. But national obligations to control certain substances, protect selected areas of global importance, take trade measures to reduce impact and so on means that mining companies are affected by many of the Conventions listed below.

Drafted and negotiated on the basis of consensus, international Conventions are legally binding instruments once a minimum, negotiated number of countries have ratified the Convention. Protocols are sometimes used to define the implementation mechanisms for specific Conventions in certain action areas, as for example the targets and methods of achieving reductions of emissions of gases that affect the global atmosphere (Montreal and Kyoto Protocols under the Vienna and Climate Change Conventions respectively). UNEP has helped to bring a number of Conventions into being, and has subsequently been designated as the Secretariat for some of them, however the Convention and its action programme remains a matter for the contracting parties.

In addition to formal Conventions, a number of international meetings result in soft instruments such as guidelines, recommendations, Declarations and policy statements. These are not legally binding, and may or may not be accompanied by implementation mechanisms. Nevertheless they remain useful policy guides for countries and industry alike. They are frequently reflected in the organisational priorities and action programmes of international institutions, national agencies and bilateral assistance programmes. In this, they may also influence the attitude to and funding priorities for mining development.

International Conventions on the environment¹

- 1971 RAMSAR Convention on Wetlands provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
- 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention). More than 150 countries are signatories. (www.unesco.org/whc).
- 1973 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention) was established to control pollution of the sea by dumping of wastes including heavy metals which could create hazards to human health or to harm living resources and marine life.
- 1979 Convention on Long-range Transboundary Air Pollution - to combat acidification and pollution from long range transport air pollutants (www.unece.org/env/lrtap).
- 1982 Law of the Sea Convention - to take measures to prevent, reduce and control the pollution of the marine environment (www.un.org/Depts/los).
- 1989 Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal - designed to minimise the generation and transboundary movement of hazardous waste which has impacted metal wastes destined for recycling (www.unep.ch/basel). In 1999, the Protocol on Liability and Compensation to the Basel Convention established rules on liability and compensation for damages caused by accidental spills of hazardous waste during export, import or disposal (www.unep.ch/basel/COP5/liability).
- 1991 Protocol on Environmental Protection to the Antarctic Treaty (PEPAT) - Article 7 prohibits any activity related to mineral resources in the Arctic region other than scientific research (www.antarctica.ac.uk/AboutAntarctica/Treaty/protocol).

stances by the year 2000. Reductions achieved to 1998, the most current statistics available, by members of the Mining Association of Canada, include: arsenic 50%; cadmium 69%; copper 54%; hydrogen sulphide 52%; lead 70%; mercury 91%; nickel 77% and zinc 82%.

Australian minerals industry code for environmental management

The Australian Minerals industry launched its Code for Environmental Management in 1996. It developed the Code to drive continuous improvement in environmental management and to be transparent in its dealings with the Community. The Code sets out key principles which companies are required to follow. It does not prescribe the details of how the companies will implement those principles, thus allowing flexibility in the improvement path. The Code is to be applied by companies wherever they operate, in Australia or elsewhere. Signatories are

required to produce public environmental reports as well as to audit their performance in implementing the Code on a regular basis.

Over 40 companies have signed on representing more than 300 mining or mineral processing operations, producing about 85% of Australia's mineral production. The Code is a dynamic document, having been evaluated and reviewed after extensive consultation. A standing community advisory panel will also help ensure its responsiveness and evolution.

As a voluntary initiative, it is regarded by practitioners in the industry as a powerful management tool to drive change. The Australian industry sees the potential for this Code to become global in application and would welcome that development. The Australian Government is strongly supportive of this industry Code as one of the most effective ways to enhance the performance and the reputation of the Australian industry

as it operates inside and outside its sovereign borders.

Conclusion

In 1998, at its sixth session, the UN Commission on Sustainable Development noted the value of voluntary initiatives and agreements in providing content and direction to the dialogue between governments, industry, trade unions, NGO's and international organizations. Although important, voluntary approaches are not the only means of addressing environmental problems. They need to be seen as complementary to other environmental policy instruments (eg. regulations, economics instruments). In fact, they are part of the continuum of voluntary, non-regulatory and regulatory initiatives

Note

¹ Technical Report No. 40. ISBN 92-807-1694-8 ♦

1992 UN Framework Convention on Climate Change – addresses the emission of greenhouse gases, to which the consumption of fossil fuels, including coal, oil and gas. This Convention was strengthened by the 1997 Kyoto Protocol committing the industrialized nations to specified, legally binding reductions in emissions of six "greenhouse gases" (carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF₆) (www.unfccc.de/resource/conv/) and (www.fao.org/WAICENT/FAOINFO/FISHERY/agreem/kyoto/kyoe.asp).

1993 Convention on Biological Diversity – to address the present trend of biodiversity loss (www.biodiv.org).

1998 Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (irptc.unep.ch/pic).

2000 UN/ECE Convention on the Transboundary Effects of Industrial Accidents aims at protecting people and the environment against accidents through prevention, reduction in frequency and severity, mitigation of effects. Agreement was reached in November on an early-warning system. (www.unepce.org/env/teia/english/intro.htm)

2000 Future Persistent Organic Pollutants Convention – affects *inter alia* dioxins and furans (www.chem.unep.ch/pops).

International Labour Organisation (ILO) Conventions and Recommendations

(ilolex.ilo.ch:1567/public/english/docs/convdisp)

1981 Occupational Safety and Health Convention and Recommendation

1985 Occupational Health Services Convention and Recommendation

1986 Asbestos Convention and Recommendation

1989 Indigenous and Tribal Convention (revised) and Recommendation

1990 Chemicals Convention

1993 Prevention of Major Industrial Accidents Convention

1995 Safety and Health in Mines Convention and Recommendation

United Nations Recommendations on the Transport of Dangerous Goods

The transportation of dangerous goods is coordinated by the UN Economic and Social Council (ECOSOC). The Secretariat is the UN/ECE. Recommendations and regulations are addressed not only to all governments for the development of national requirements but also to international organizations such as: the International Maritime Organization; the International Civil Aviation Organization and regional commissions such as the Economic Commission for Europe. (www.unepce.org/trans/danger)

"Soft Laws" (i.e. not binding) principles and instruments

1989 Cleaner Production Programme: UNEP's Governing Council launched its Cleaner Production programme to "continue its catalytic role to promote with Governments, industry, research organizations and other relevant institutions the establishment of a network which will allow the transfer of environmental protection strategy. The CP Declaration is a tool to actively promote front end technological improvements to eliminate pollution rather than using the more traditional end-of-pipe solutions to reduce or mitigate the effects of pollution. (<http://www.unepie.org/Cp2/declaration/home.html>)

1992 Rio Declaration and Plan of Action (updated in 1997) – Agenda 21 deals with topics related to the mining activities, such as Planning and Managing of land resources (chapter 9), Deforestation (chapter 10), Atmosphere (chapter 15), Oceans and Seas (chapter 17), Freshwaters (chapter 18), Toxic Chemical (chapter 19), Hazardous Wastes (chapter 17), Business and Industry (chapter 31)

1999 Mining and Environment "Berlin Guidelines" (revised)

¹ Summaries and full texts can be obtained from the United Nations Environment Programme Register of International Treaties and Other Agreements in the Field of Environment (<http://sedac.ciesin.org/pidb/register-home.html>)

Mining Minerals and Sustainable Development (MMSD) Project

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MMMSD is an independent process of multi-stakeholder engagement and analysis with the objective of "identifying how mining and minerals can best contribute to the global transition to sustainable development". Beginning in April 2000, it is a two year project designed both to produce concrete results during this period, and to create structures capable of being carried forward thereafter.

MMSD was initiated by the World Business Council for Sustainable Development (WBCSD) as one of a number of projects initiated by the Global Mining Initiative (GMI). The Project is independent of the Global Mining Initiative and managed by the International Institute for Environment and Development (IIED),¹ under the supervision of a distinguished international Assurance Group.

MMSD's objectives are fourfold. First, there is a need for *analysis* to assess global mining and minerals use in terms of the transition to sustainable development. Second, what are the *future scenarios* to identify if and how the services pro-

vided by the minerals system can be delivered in accordance with sustainable development in the future. Third, propose key elements of an *action plan* for improvement in the minerals system, and fourth, *create mechanisms* to identify how mining and minerals can best contribute to a global transition to sustainable development.

To achieve these objectives, four main elements have been identified: research and analysis; stakeholder engagement; communication and implementation.

MMSD represents a unique attempt to bring together the actors affected by the minerals cycle including exploration for deposits, construction of mines, mining operations, closure and rehabilitation and the use, reuse, recycling and final disposal of mineral products. MMSD views itself as an agent of change for the transition to a more sustainable society which will require all social actors to change the way they produce, use recycle and dispose of resources.

The Project, directed by Luke Danielson is centred at the IIED in London, England. It is in the

process of creating a series of regional partnerships and has a unique, albeit complex governance structure. But it is working to get the process right – to be as transparent and open as possible so as to create conditions in which as wide as possible a set of stakeholders feel they can engage with confidence that their efforts can influence the Project's outcomes. Information is easily available on the MMSD website (www.iied.org/mmsd).

Mineral resources have throughout history been a critical part of the human economy, and the way they are produced and used has had a profound effect on human society and culture. This is obvious by our very characterization of much of the human past as the Stone Age, the Copper Age, the Bronze Age and the Iron Age. It is therefore, reasonable to believe that a major shift in the way human societies operate is likely to produce – or be produced by – changes in the conditions under which minerals are produced and consumed.

The timelines for the MMSD Project are very tight as the Project Report is scheduled to be presented at the GMI meeting in Toronto, Canada in May 2002 so as to be presented to the Rio +10 high level summit in 2002. Expectations are high that this Project will contribute significantly to everyone's understanding of sustainability and the role of mining minerals and metals.

Note

¹ GMI was formed by the Chief Executive Officers of several of the world's principal mining companies.

Accident prevention and environmental safety in mining: the role of governments

Improving mining safety around the world is a responsibility of governments and of companies. With accidents, particularly tailings spills, happening in developed and developing countries alike causing increasing concern amongst communities and governments, the time was ripe for an initiative to bring mining regulators together to focus on ways to achieve the common objective of accident prevention.

Together with the Australian Government, UNEP hosted a *Workshop on Environmental Regulation For Accident Prevention in Mining – Tailings and Chemicals Management*. Held October 2000, in Perth, Australia, it was the first major international gathering of regulators to share experience, practices and problems associated with regulation of the high hazard components of mining. Forty-five regulators and professionals attended from some 20 countries.

Participants compared the actions which various governments had taken to prevent accidents and improve environmental safety at mines. A large number of common issues, objectives and approaches emerged in spite of the differences in size, scale or age of the various countries' mining industries and the different geological and climatic environments which host mines. Participants benefited from the preparedness of governments which had experienced a major mining accident sharing what they had learned and the changes they had made to their permitting and oversight procedures as a result. Participants from developing countries currently opening up new mining operations found the information particularly timely.

Key issues which emerged at the Workshop included:

- ◆ How to adapt regulations and permitting procedures to efficiently and effectively cover a non-homogeneous industry with big and small players, different site specific circumstances, high performing companies and companies operating to recognised systems or Codes along with poor performing companies;
- ◆ Specific ways to improve permitting, monitoring and oversight of tailings

facilities, especially different requirements for critical review before approvals, plus effective inspection and reporting regimes. The competency and authority of regulators to intervene in the event of a problem was a related issue;

- ◆ Identification of early warning signs of impending accidents;
- ◆ The need to build and maintain appropriate skills, expertise and resources to enhance regulatory capacity;
- ◆ Evolving interface between industry codes and regulation, and evolving regulatory tools including differential approaches to financial or oversight provisions for different performers;
- ◆ Community participation and involvement in approaches to decision-making, oversight and emergency awareness and preparedness.

The presentations represent a resource for all governments as well as the papers on each country's issues and practices. The resulting network will facilitate the international spread of new regulatory approaches.

The Workshop made significant progress towards finding better ways of regulating potentially hazardous aspects of mining, and many of the participants were keen that this not be a one off event. Regular exchanges between governments would help accelerate the evolution of international thinking and practice amongst governments. UNEP is also of the view that a regular Mining Regulators Forum should be seriously considered. "Mining is a global activity and it is perhaps remarkable that there is no such regular exchange already taking place". (Klaus Töpfer, Nov 2000)

The legacy of the Workshop should be more effective government oversight in support of the industry's own efforts to reduce the number of accidents. This will allow the benefits of the mining industry to continue to accrue to consumers, companies and countries alike as confidence is regained in the industry's safety.

Workshop papers have been posted on UNEP's Minerals Resources Forum website (www.natural-resources.org/environment).

Viewpoints on future challenges

Environment, multi-culturalism and human rights: challenges for the mining industry and governments

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The challenges for mining and sustainable development over the coming decade are numerous and varied. If the 1980's and 1990's saw environmental imperatives affecting corporate practice, the turn of the millennium is witness to the rise of the social imperative. From this perspective one could mention the following challenges:

- ◆ Providing and facilitating access to relevant and adequate information for improved participatory decision-making and understanding of trade-offs with regard to mineral development.
- ◆ Developing transparent, efficient and reliable environmental and social evaluation and monitoring systems that are meaningful to all stakeholders.
- ◆ Making lasting partnerships between corporations, communities and governments for the sustainable and equitable development of mining localities and regions.
- ◆ Designing and applying intercultural mechanisms for resolution of conflicts over natural resources in indigenous territories.
- ◆ Developing and implementing mine closure and rehabilitation laws and practices.
- ◆ Finding ways to make artisanal and small-scale mining sustainable, in every sense of the word.
- ◆ Building capacities of local governments to deal with the multiple challenges of mineral development.

Perhaps the most crucial question is: how can large scale mining and mineral processing contribute to increased well-being, equity and sustainable development of mining regions and localities in the developing world?

The answers are diverse and multi-dimensional, and are likely to be voiced from multiple cultural perspectives in today's world. In effect, the outcome of mining in each particular mining region – in terms of its contribution to equitable and sustainable development – will not depend only on the performance of the mining companies. It will also depend on the capacity and performance of other key stakeholders such as the local, regional and national governments, the different groups and civil organizations within the communities themselves and even advocacy groups at the global level. I will address the key challenge of complete and respectful communication and engagement of stakeholders as one of the main requirements for moving towards more equitable and sustainable development of mining regions.

Due to the nature of global geopolitics and the global economy, many developing country governments are forced to make decisions where the implications of the trade-offs involved are not properly known or understood. In the developing world, short-term realities usually dictate that the decision-making process tends to take place under the pressure of growing social unrest and of the effects of economic globalization and structural adjustment. The structural restrictions that make for imposed decisions tend to broaden the gap between participatory demagoguery and meaningful public participation. The urgency for much needed foreign direct investment and the need to generate jobs means that the medium and long term strategic importance of biodiversity may be minimized, the rights and ethnic integrity¹ of indige-

nous peoples deemed contrary to national interest, potential public health hazards ignored, and the diversified livelihoods of rural dwellers undermined. In the same way that developing countries are restricted in their development options by an unlevel global market and playing-field, so local communities find their needs and priorities mandated by central governments. It is in this context of differences in power, capacity and degree of freedom of choice that mining takes place.

The liberalization of investment regimes and the globalization process have brought the rapid expansion of mining activities to areas previously isolated from mainstream development processes in many developing countries. Many of these areas coincide with territories traditionally occupied or used by indigenous and other traditional rural peoples as the basis of their livelihood². Many of these regions are also characterized by cultural and biological diversity and are fragile ecosystems (e.g. desert, mountain or tropical forest)³. Most of them are areas where basic public services are either lacking or deficient, where indeed the "presence" of the government may be very weak, and where there is likely to be a high level of expectation that large mining companies will deliver these services. A common situation in many localities is that local communities do not have freedom of choice. Solutions to problems of social and economic rights and minerals development are presented in the discourse of both governments and mining companies as one and the same thing. The promise of "development" dominates the communication scenario in the early phases of mining, but in general this develop-

site manager, the Mountain Institute, the national environmental agency INRENA and the IUCN representatives from Peru. This working group was instrumental in dealing with issues such as monitoring of the temporary use of the central road across the park and reviewing potential impacts on the wildlife.

The case of Lorentz National Park (Indonesia) led to a lengthy debate at the December 1999 session of the World Heritage Committee, and several delegates noted the issues of mining concessions and adjacent oil concessions as well as other impacts on the site, such as road construction and visual impacts related to these operations. The World Heritage Committee inscribed the site as the largest protected area in Southeast Asia (2.35 million ha) and the only protected area in the world which incorporates a continuous, intact transect from snow cap to tropical marine environment. The site is also clearly of outstanding universal value for its high level of biodiversity and endemism. At the same session, the Committee reduced the inscribed area at the request of the Indonesian authorities by 150,000 ha to exclude

oil exploration concessions. The case of Lorentz National Park is illustrative of the complexity of the issues to be discussed concerning World Heritage areas.

Other cases such as Greater St. Lucia Wetland Park (South Africa) or Yellowstone (United States) mainly illustrate the processes of mining leases and the decision of the State Party not to allow mining within or next to an area identified for World Heritage listing or an existing World Heritage site. Table 1 also shows the number of times the World Heritage Committee dealt with specific cases, such as Mt. Nimba Strict Nature Reserve, a transfrontier site between Guinea and Cote d'Ivoire. In 1993 an expert mission was sent to review the boundary changes requested by the Government to accommodate exploitation of the iron-ore mine at Mount Nimba. Following the expert's recommendations, the boundaries of the World Heritage site were changed, although the total area was not reduced. Continuous negotiations are being held to ensure an integrated development of the Mount Nimba region and to take all measures to protect the World Heritage area.



The site was included in 1992 in the List of World Heritage in Danger, because of "the real dangers of exploitation of the mine and the arrival of large numbers of refugees".

For the first time, in 1998 and 1999, the World Heritage Committee and its Bureau discussed the question of mining and World Heritage in general terms. Following the September technical workshop on "Mining and World Heritage", a set of recommendations was presented to the World Heritage Committee in Cairns in November-December 2000. The report containing the decision of the World Heritage Committee will be made available on the webpages of the UNESCO World Heritage Centre (www.unesco.org/whc). It is necessary to share information between the different actors dealing with World Heritage and to review cases of good practice, as well as lessons learnt from disasters such as the situation around Doñana National Park. This could be the basis for a better national and international collaboration to ensure that the World Heritage sites are conserved for future generations.

Mining and protected areas: an IUCN viewpoint

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The impact of mining and mining-related activities on protected areas is currently much in the news. In recent years there have been a string of controversial and well-publicized cases affecting a number of the world's great natural sites. Examples include Kakadu (Australia), Mt. Nimba (Guinea/Ivory Coast), Lorentz (Indonesia), Huascarán (Peru), Kamchatka (Russia), Doñana (Spain), Canaima (Venezuela), and Yellowstone (USA). These are all World Heritage sites, but the issue of mining and associated activities also affects many more of the world's growing number of protected areas. As a result the topic has recently been on the agendas of the World Heritage Committee and of the World Conservation Congress (WCC) – see below. It is a key theme in the Mining, Minerals and Sustainable Development (MMSD) project² and also concerns governments, mining companies, environmental bodies and citizens groups around the world. This short article sets out IUCN's position on this issue and considers the challenge which the topic poses for the mining industry.

IUCN Protected Area Management Categories

Protected area managed mainly for:

- Ia: science
- Ib: wilderness protection
- II: ecosystem protection and recreation
- III: conservation of specific natural features
- IV: habitat and species management
- V: landscape/seascape and recreation
- VI: sustainable use of natural resources

(for a fuller explanation, see IUCN, 1994, *Guidelines for Protected Area Management Categories*)

Conflict over mining and protected areas issues is becoming more common. This is because the number of protected areas continues to grow (see below), and because knowledge of mineral potential and new mining techniques now makes it possible and profitable to work in places which were previously ignored or avoided due to their remoteness or because of the high costs involved. Further,

as awareness of the importance of protected areas has grown, so has concern over the negative impacts that mining and related activities can give rise to. The stage is therefore set for greater conflict in the future unless ground rules can be agreed between all concerned. IUCN is working to help develop such ground rules.

IUCN is a global alliance of member States, government agencies and non-governmental organizations committed to the conservation of nature and to ensuring that any use of natural resources is equitable and ecologically sustainable. As well as its members and a secretariat operating in more than 40 countries, IUCN works through volunteer networks of experts, or commissions. One of these is the World Commission on Protected Areas (WCPA), involving a thousand or so people with expertise in every aspect of protected area management. WCPA is concerned with all protected areas, but it also has a particular part to play in assisting IUCN in its role as advisor to the World Heritage Committee on natural sites. In the light of the difficulties which many protected

area agencies and managers have recently encountered in dealing with mining and protected areas, WCPA developed a position statement on this topic in 1998. It covered all forms of mining and mineral extraction, including that of fossil fuels, as well as related activities, such as processing, transport and settlement, whose environmental impact can be greater than that of extraction itself.

The status of this WCPA position was that of a peer-reviewed document prepared by experts in WCPA's own network, and also from other parts of IUCN. Consultations on the draft were held with the International Council on Metals and the Environment (ICME). At the recent WCC, held in Amman, Jordan, (4-11 October 2000), IUCN's members adopted a resolution on this subject, based in large part on the WCPA position. The resolution (reproduced as an annex to this article) provides IUCN with its current formal position on this topic.

The starting point behind WCPA's work, and of IUCN's effective endorsement of it, is the significance of protected areas. These have been defined by IUCN as follows: "an area of land/and or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means". Most countries have set up places that meet this definition, seeking to protect the integrity of nature in selected sites permanently. The importance of protected areas at the national and international levels is growing. For example, protected areas are one of the main means by which countries can fulfill their obligations under the Convention on Biological Diversity. The World Conservation Monitoring Centre, which maintains the world protected areas database for IUCN/WCPA, reports that there are more than 30,000 protected areas meeting this definition and covering about 9.6 per cent of the land surface of the earth. This is roughly equivalent to the areas of India and China together.

Through WCPA, IUCN has developed a system of categorizing protected areas by reference to their principal management objectives, as shown in the box below. This categories system – now widely used by governments and others – is critical to shaping WCPA's, and hence IUCN's, policy towards mining.

As will be seen from the resolution adopted in Amman, IUCN believes that mining should not take place at all in the first four categories and only under strict conditions under categories V and VI (together these two categories account for about 30% of the land under protection). IUCN also believes that if it is proposed to alter protected area boundaries so as to permit mining or related activities, a proper and exacting process should be gone through. De-designating a protected area, or a part of it, is not to be undertaken lightly. Also IUCN is concerned to ensure that mining and related activities near protected areas do not adversely impact on their values.

The original WCPA position statement contained several other important points. It recognized that countries would need to adapt the

Resolution adopted at the Second World Conservation Congress on the Protection and Conservation of Biological Diversity of Protected Areas from the Negative Impacts of Mining and Exploration, October 2000

CONSIDERING that protected areas of various definitions and categories are home to a substantial portion of the earth's biological diversity, threatened species, indigenous communities, lifestyles, and cultures;

NOTING that protected areas act as an important natural system for the regulation of the world's climate balance;

RECALLING that a large majority of State members of IUCN are signatories to the Convention on Biological Diversity;

ACKNOWLEDGING that many of IUCN's State members have established national sys-

tems of protected areas to guarantee the conservation of biological diversity;

CONCERNED by the negative social and environmental impacts associated with the rapid growth of mining and mineral exploration activities world wide with particular reference to the risks posed to the preservation of biological diversity in protected areas;

RECOGNISING that the positive endeavours of States, environmental groups, and threatened communities require strong legislative instruments to strengthen their efforts for nature conservation;

**The World Conservation Congress at Its 2nd Session
In Amman, Jordan, 4-11 October 2000:**

1. **INVITES** all governments and corporations to promote and implement best practice in all aspects of mining and mineral extraction, from first exploration through to decommissioning and subsequent land use;

2. **CALLS** on all IUCN's State members to prohibit by law, all exploration and extraction of mineral resources in protected areas corresponding to IUCN Protected Areas Management Categories I to IV;

3. **RECOMMENDS** that:
(a) in categories V and VI, exploration and localised extraction would be accepted only where the nature and extent of the proposed activities of the mining project indicates the compatibility of the project activities with the objectives of the protected area;
(b) authorization for localised exploration and mining require an environmental impact assessment (EIA) of the project and approval by the relevant competent authority and stakeholder groups after public disclosure of the EIA draft document; and

(c) authorized exploration and mining projects be subject to strict planning, operating, monitoring, and post-use restoration conditions;

4. **URGES** that proposed changes to the boundaries of protected areas, or to their categorization, to allow for the exploration or localized extraction of mineral resources, should be subject to procedures at least as rigorous as those involved in the establishment of the protected area in the first place;

5. **RECOMMENDS** that exploration and extraction of mineral resources and allied infrastructure development work, which is outside of a protected area, but which may negatively affect the values for which the protected areas were established, should be subject to:
(a) EIA preparation and approval from relevant competent authority and stakeholder groups after public disclosure of the EIA draft document; and
(b) strict planning, operating, monitoring, and post-use restoration conditions.

global statement regarding mining and the categories of protected areas to local circumstances. It also pointed out that a proper knowledge of natural and mineral values was essential before new protected areas were set up. It specifically recognized that mining companies can and do make important positive contributions to biodiversity conservation and indeed to the success of some protected areas (e.g. by supporting research or helping to meet management costs), and thus WCPA argued for more dialogue and collaboration with the mining sector in future. While these points are not found in the words of the IUCN resolution, they are certainly very relevant to future practice. For example, much common ground was found at a recent seminar organized by IUCN and ICME over the issue of mining and World Heritage sites, though ICME is not at pre-

sent able to accept the idea that World Heritage sites should be "no go" areas for mining in future.

IUCN's position is therefore that protected areas need to be protected – and that mining and related activities are not, in principle, compatible with the objectives of certain categories of protected areas. The challenge to the mining industry, and to the government departments around the world which control their activities, is to ask themselves whether they should even consider new mining operations within protected areas, and to review on-going activities of this kind. However, providing the special status of protected areas is acknowledged, IUCN believes there is much scope for cooperation with the industry, and that a potentially large common agenda can be developed, based around best mining practice and other areas of collaboration.

This Recommendation (see box) was adopted by a show of hands. The delegation of the State member United States made a formal Statement for the Record indicating that it had opposed and voted against the Recommendation, noting that mining policy is an internal matter for sovereign states, and reiterating that, "in the US, management of parks and requirements for environmental assessments are based on domestic laws and regu-

lations, not a global framework. In this context, the US Government has acted strongly to limit mining where it is not appropriate". The full Statement is reproduced in the Congress Proceedings.

Notes

¹ Adrian Phillips was the Chair of IUCN's World Commission on Protected Areas 1994-2000, and is now the vice chair of WCPA for World Heritage.

² The MMSD is managed by the International Institute for Environment and Development. It is an initiative of the World Business Council for Sustainable Development and is supported by the CEO's of some 25 of the world's principal mining companies. It aims to identify how mining and minerals can best contribute to the global transition to sustainable development.

La minería en la encrucijada de la sustentabilidad

Adam Rankin e Hildebrando Velez,
CENSAT AGUA VIVA- FoE Colombia

La historia contemporánea de América Latina está signada por la minería. Ella hace parte de las esperanzas y tragedias de nuestros pueblos, de la formación de nuestras culturas y paisajes, de la codicia y del progreso, de los impulsos empresariales de los capitales nacionales y extranjeros. Ella está en los ríos y en las montañas mágicas y erosionadas, está en el verbo de los indígenas y de los afroamericanos.

El pasado está presente en el futuro, como el futuro tiende sus raíces en el pasado. Caracterizar cómo será la minería en la década presente lleva a referirnos a las tendencias que encontramos en el presente. Las huellas están acá, son cicatrices en el paisaje, son historias en las novelas, son narraciones en las noches negras en el pacífico colombiano, son ritos y ceremonias de los indígenas de la Orinoquía y la Amazonía para que la Madre Tierra no sea profanada.

Los siguientes ejemplos muestran lo hechos y plantean cuáles son los retos de la minería:

El gobierno peruano ha puesto una multa de \$500.000 dólares en contra de la mina de oro Yanacocha en Perú, debido a un derrame de un camión que cargaba mercurio de la mina. La gente recolectó el mercurio del derrame y lo metieron a sus casas. Una mujer, fue envenenada seriamente y se encuentra en coma y muchos otros fueron examinados y tratados. (*Elko Daily Free Press*).

Los trabajadores de la mina de estaño Huanuni en Bolivia iniciaron una huelga con el fin de denunciar a la compañía extranjera encargada de la mina por su falta de respuesta a las demandas sobre el pago, seguridad laboral y condiciones labo-

rales. (*El Diario - La Paz*).

Desde su establecimiento, en 1976, Carbocol ha contratado empréstitos con la banca internacional por un monto aproximado a los US\$2.242 Millones, con una tasa de interés promedio aproximada de 10.9%... De estos créditos, Carbocol ha cancelado un total de US\$698 millones y la Nación ha cancelado en su nombre US\$461.2 millones... Actualmente el pasivo financiero [es] de US\$1.082,7... Desde 1985, Carbocol sólo ha dado ganancias en 1996 por un monto de col. \$230 mil millones... sin embargo ha producido ganancias operacionales sostenidamente desde 1988. (*Carta del Ministro de Hacienda de Colombia, Juan Restrepo, nov-02-99*)

A pesar de las políticas que procuran la protección medio ambiental y la participación comunitaria, la minería sigue causando altos impactos sobre ecosistemas, destrucción de las culturas tradicionales y deterioro de la salud ocupacional y pública. Pablo Neruda lo dijo poéticamente: "Madre de los metales, te quemaron, te mordieron, te martirizaron, te corroyeron, te pudrieron más tarde, cuando los ídolos ya no pudieron defenderte.....".

Los negocios mineros han resultado poco atractivos para las comunidades y países poseedores de la riqueza pero bastante para los inversionistas extranjeros. El reto más significativo para la minería es mostrar que puede articularse a la búsqueda de la sustentabilidad de las sociedades. Para ello deberá dejar de orientarse por las necesidades de acumulación de capital en pocas manos y dirigirse a satisfacer las necesidades esenciales de la socie-

dad y con ello contribuir a resolver los problemas del hábitat humano, de las tecnologías eficientes y baratas, de la seguridad alimentaria, de las comunicaciones, de la vivienda adecuada y perenne, conservando los ecosistemas y la vida.

Si darse un sentido ambiental y ético, la minería traerá pobreza, enfermedad, destrucción ambiental y desintegración social. Por ello, el imperativo ético del empresariado minero debe llevarle a la construcción de condiciones de equidad y bienestar de las sociedades presentes y futuras.

En América Latina la experiencia de los pueblos donde ha habido minería no es halagüeña, bien sea por los impactos ambientales o por la efímera y esquiva prosperidad económica. Por ello la explotación de bienes mineros deberá hacerse en los márgenes de resiliencia de los ecosistemas, preferiblemente por empresas con alta participación de los actores locales y de los trabajadores y para el beneficio social. La actividad económica minera deberá concordar con los planes de vida de las comunidades y contribuir a la solución de las demandas históricas de la sociedad, así como a cimentar el futuro deseado en la región para hacer un uso racional de los minerales y construir una economía sostenible, solidaria y diversificada.

Desde la perspectiva enunciada surgen objetivos para asumir durante esta década:

- ◆ Buscar condiciones de intercambio económico y comercial justas entre países, entre regiones y entre grupo sociales asociados a las actividades mineras.
- ◆ Desarrollar tecnologías mineras apropiadas e impulsar la investigación aplicada y básica, tanto en las disciplinas técnicas como en la humanidades.
- ◆ Fortalecer medios y procesos de socialización del conocimiento minero, escolarizados y no escolarizados.
- ◆ Concertar estrategias para manejar adecuada y oportunamente los impactos ecológicos y sociales de la minería en todas las fases, incluida la etapa de cierre de la mina. Esto implica integrar de forma clara y lógica los planes de gestión ambiental participativa con los procesos de planeación minera y desarrollar mecanismos de prevención de riesgos.

- ◆ Aprovechar racionalmente los minerales y darles valor agregado, dentro de procesos de ordenamiento territorial concertado, y teniendo en cuenta las generaciones futuras.
- ◆ Asesorar, en todas las escalas de minería, el empleo de tecnologías de producción y transformación apropiadas y limpias y promover una cultura minera con responsabilidad social y ecológica.
- ◆ Desarrollar veedurías de la salud ambiental minera con participación de autoridades locales, empresas y grupos de interés.
- ◆ Implementar una ética de la administración pública que vele por la adecuada asignación de excedentes financieros y de regalías mineras, conforme con las necesidades esenciales de la población.
- ◆ Promover y fortalecer las organizaciones loca-

les, de mujeres mineras y afectadas por la minería.

- ◆ Promover alternativas culturales, sociales y económicas que permitan la erradicación del trabajo infantil en la minería.

Asegurar el reconocimiento de los derechos culturales y territoriales de los pueblos indígenas y comunidades tradicionales que son vulnerados frecuentemente en las actividades mineras. ◆



Future challenges for the large-scale mining industry

Amy Rosenfeld Sweeting, former Director, Energy & Mining Initiatives, Conservation International, 2501 M Street, NW, Suite 200, Washington, DC 20037, USA

Introduction

In the last several decades, the international mining industry has expanded rapidly into all corners of the world. Growing global demand for minerals, combined with an increasingly open economic and political climate for investment in much of the world has meant that areas that were once all but inaccessible to large-scale development are now available and attractive investments. Much of this expansion has been away from the more traditional, developed mining areas and into many of the less-developed and largely unexplored countries of tropical Latin America, Africa and Asia.

While many of these countries offer vast mineral resources, they also often contain tremendous stores of biological diversity, the wealth of species, ecosystems and ecological processes that make up life on Earth. As this expansion continues and potential conflicts arise between industrial mineral development and conservation, the challenge for the large-scale mining industry will be to ensure that its presence in ecologically sensitive areas results in a net benefit for conservation.

Net Conservation Benefit

Large-scale mining projects in sensitive ecosystems can present significant risks and opportunities for biodiversity conservation in these areas. While mining can cause serious direct and indirect damage to air, water, soil, habitats and ecosystem health, the presence of a large mining company will also often represent an important resource for support of and contributions to conservation on the ground.

Increasingly, it is becoming apparent that the ethical responsibilities of a large industrial developer in a sensitive ecosystem do not end at simply mitigating any potential negative environmental impacts. In many ways, the "cost of doing business" in such areas also includes contributing to conservation in a proactive and meaningful way.

Ensuring a net benefit to conservation in an area simply means that the positive benefits of a project's presence outweigh its negative impacts so that the end result is improvement rather than degradation of an ecosystem. This equation has two basic components: minimizing and mitigating the negative impacts of an operation, and making some form of positive contribution to conservation.

Positive Contributions to Conservation

In recent history, the large-scale mining industry has come a long way in developing technologies and techniques for understanding and minimizing negative impacts. Yet, while much of this knowledge is becoming standard practice throughout the industry, the other half of the net benefit equation, making a positive contribution to biodiversity conservation, has yet to become the norm of large mining projects worldwide. Nevertheless, in remote and sensitive ecosystems, improving the state of conservation is equally as important as reducing any potential negative impacts of a project.

The scope and type of any contribution to conservation should be determined by the expected impact of a project, based on data gathered during the environmental assessment process, as well

as a baseline evaluation of the ecological characteristics and needs of a specific ecosystem. Companies should work with non-governmental organizations (NGOs), local communities, government authorities and other interested parties to design the most appropriate activities. The most straightforward type of contribution might be the creation of a long-term trust fund for conservation in an area, or to make a deposit to an already existing fund. Investments could also include financial or in-kind support for the management of a national park system, participation in the creation and management of a new protected area, government training and capacity-building, contributions to national biodiversity strategies, educational programs, support for scientific research or contributions to existing conservation efforts.

Any positive contribution should be one half of a two-part integrated environmental management strategy, with negative impact minimization being the other half. A positive contribution should never be seen as "permission" to damage the environment or develop in any available location. Nor should it be considered an excuse to degrade pristine land while restoring or conserving environmentally marginal land. At the same time, advanced impact mitigation or minimization practices are not a substitute for positive contributions. No matter how carefully a project is designed and implemented, it will always have some level of negative impact, and achieving a net benefit will require additional offsetting activities.

Impact measurement

A strategy for minimizing negative impacts and promoting positive impacts involves a key assumption: that the company will be able to reliably measure the level of positive and negative impacts in order to calculate the cumulative effect. To do so requires a standard set of biodiversity metrics to measure both the extent and character of a project's impact, an index that can be applied to any project anywhere. Such a "footprint metric" would allow companies to more credibly demonstrate their performance to regulators, communities and activists, while NGOs and governments would be better able to evaluate the

merits of existing and proposed projects.

Any standardized metric would include both qualitative and quantitative "indicators" that could be monitored over time to determine cumulative impacts and changes. A full understanding of such changes requires accurate baseline data on the condition of the ecosystem before the project activity began.

The most straightforward ecological indicator for measuring project impact is land-take. By comparing the number of hectares severely disturbed or converted – directly or indirectly – by the operation to the number of hectares under some form of conservation supported by the project, enables a company to determine whether the net impact on land is positive or negative. (The land in conservation should always be of the same or greater biodiversity value as the land being converted.) Such a calculation can be done at a project, regional, national or company-wide level.

But conservation is more than just counting hectares. The health of ecosystem functions that depend on complex water, air, soil and animal

movements and interactions cannot be measured just by land-take. Other measurements, such as the level of impact on particular species or changes in water, soil or air pollution, are also necessary to get a complete picture of the impact of a project.

Finally, in addition to tangible indicators of ecosystem health, such as species counts and numbers of hectares, other contributions will benefit conservation on a broader level. For example, financial or in-kind support for training in conservation practices or park management can have an important impact on the security of protected areas that can't always be readily measured in hectares. Support for infrastructure and monitoring of access to an area can help prevent unauthorized incursions and indirect impacts from land-clearing and colonization. Funding or support for biological research and data collection can contribute to general knowledge of biodiversity in an area and improve the quality of impact assessment and monitoring programs. None of these impacts are easily quantifiable, but all are equally important.

Conclusion

The large-scale mining industry has already made great strides towards understanding and addressing the potential impacts of their operations in sensitive ecosystems. Environmental impact statements and management plans are standard practice at most major projects around the world, and advanced technologies and practices are routinely used by progressive companies to minimize and mitigate environmental impacts. As a result, the potential negative effects of a large mine's presence in a sensitive environment can be greatly reduced.

Nevertheless, as these operations advance into the world's last remaining undeveloped and biodiversity-rich ecosystems, simply reducing negative impacts is not enough. Companies operating in these areas also have an ethical responsibility to make a positive contribution to conservation, to ensure that their presence has a net benefit to the ecosystem and that the area is in better condition when they leave than when they arrived.



Mining and metals processing: the commitment to sustainable development

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Many companies in the global mining and metals processing sector have made notable progress in the past 10 years in embracing the elements of sustainable development. Companies can provide sustainable economic, environmental and social benefits to the communities and regions in which they operate. Towards this end, many companies have now put in place environmental and, in some cases, community policies, together with management systems that require regular audits and public reporting. A committee of the Board of Directors overseeing corporate environmental performance is also common in most major companies. Further, more and more companies have adopted sustainable development as a context for their corporate objectives. The benefits of integrating environmental, social and economic aspects into the decision-making process are being increasingly recognized. Stakeholder consultations and participation are now seen as integral to this process and to achieving common objectives.

From the perspective of ICME, society's pur-

suit of sustainable development is a dynamic process that will continue to evolve over time in response to changing social values and priorities. Sustainable development involves values and principles that guide corporate policies and practices.

Recently, commitments to sustainable development by ICME members took the form of decisions by the Board of Directors to sign the United Nations Declaration on Cleaner Production and to amend the ICME Sustainable Development Charter. The new Charter outlines members' commitments to sustainable development, which will guide them into the new millennium.

The new ICME Charter contains management principles in four key areas: Environmental Stewardship; Product Stewardship; Community Responsibility; and General Corporate Responsibilities. ICME members acknowledge through the Charter that sustainable development is a corporate priority, which expresses a commitment to high quality in their economic, environmental and social performance.

In the early years of this new millennium, sig-

nificant challenges must be addressed by members and regions where these activities take place.

ICME seeks to work in partnership with international organizations, governments and other stakeholder groups on behalf of the industry to promote the implementation of sustainable development policies and practices. With respect to specific sustainable development challenges currently facing the global mining and metals processing industry, ICME is currently addressing a number of important issues, for example:

- ◆ Tailings management: Golder Associates, with funding from ICME, finalized a study in October 2000 assessing the need for an International Guide for Tailings Management. ICME presented the results at a workshop co-hosted by UNEP and the Government of Australia on Mining held in Perth, Australia in October 2000;

- ◆ World heritage and mining: A workshop organized by IUCN, in partnership with ICME, was held in Gland, Switzerland in September 2000 to develop a set of principles regarding mining in areas adjacent to World Heritage Sites; and

- ◆ Cyanide management in gold mining: ICME and UNEP convened a multi-stakeholder workshop in Paris in May 2000 to consider the development of an international voluntary Code of Practice for the management of cyanide in the industry as a result of the Baia Mare incident in Romania.

By working together with international and domestic partners, and with a clear commitment of the industry to the principles of sustainable development, a positive legacy of economic, environmental and social benefits can be realized from global mining and metal processing activities in the coming decades of the 21st century.

THE UNEP DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS

Current uses and development of natural resources, technologies and production processes, as well as urbanization patterns, have negative effects on human health and the environment. This is illustrated by unsustainable use of water, land and energy, air and water pollution, persistent and toxic bio-accumulative chemicals in the food chain, and other industry-related problems. To have a healthy environment, we need to change how we produce and consume goods and services. This change involves revising and developing economic policies and trade practices so as to integrate environmental issues in the planning and assessment processes.

UNEP's Division of Technology, Industry and Economics (UNEP DTIE) was created in 1998 to help decision-makers in governments, local authorities and industry develop and adopt policies and practices that:

- are cleaner and safer;
- use natural resources efficiently;
- ensure adequate management of chemicals;
- incorporate environmental costs;
- reduce pollution and risks for humans and the environment.

UNEP DTIE, whose main office is in Paris, is composed of:

♦ **The International Environmental Technology Centre (Osaka)**, which promotes the adoption and use of environmentally sound technologies, with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.

♦ **The Production and Consumption Unit (Paris)**, which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in the use of natural resources and reductions in pollution.

♦ **The Chemicals Unit (Geneva)**, which promotes sustainable development by catalyzing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety world-wide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).

♦ **The Energy and Ozone Action Unit (Paris)**, which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISØ Collaborating Centre on Energy and Environment supports the work of this Unit.

♦ **The Economics and Trade Unit (Geneva)**, which promotes the use and application of assessment and incentive tools for environmental policy, and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.



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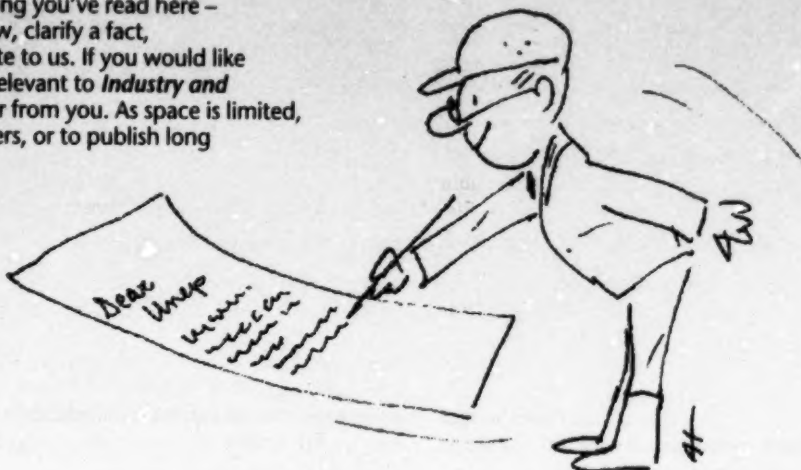
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